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400 Plaza Building
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Naval Training Equipment Center
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This report describes a pilot study undertaken during the first phase of a research effort designed to assess the training effectiveness of visual display system variables for aircraft carrier qualification training in the Navy Jet Undergraduate Pilot Training program. The purpose of the pilot study was to develop information useful to the development of a recommended experimental design for a full-scale

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) transfer of training experiment using the Navy's Visual Technology Research Simulator and the T-2 aircraft. Feasibility concerns related to (1) simulator variables, (2) performance assessment, and (3) logistic and administrative problems are addressed. Seven student naval aviators participated in the study. Study results supported other first phase findings that conduct of a full-scale transfer of training study is feasible.

FOREWORD

This report describes a pilot study undertaken during the first phase of a two-phase research effort designed to assess the training effects of visual display system variables for aircraft carrier qualification training in the Navy Jet Undergraduate Pilot Training program. The first phase of the effort has been concerned with the feasibility of conducting a full-scale transfer of training experiment using the Navy's Visual Technology Research Simulator (VTRS). The transfer experiment is to be conducted as Phase II of the effort. The pilot study reported here represents only one aspect of the Phase I investigation. Other Phase I activities and a recommended research plan for Phase II are reported in a companion document, "VTRS Transfer of Training Experiment: Phase I--Experimental Design."

The work reported here was carried out by Seville Research Corporation under Requisition No. 0155-1P16 for Rowland and Company under Contract N61339-80-D-0009 with the Naval Training Equipment Center, Orlando, Florida. Dr. Wallace W. Prophet was Program Manager for Seville, and Mr. Robert N. Isley was Project Director. Dr. William D. Spears was responsible for the data analyses. In addition, Dr. William V. Hagin and Mr. Winon E. Corley of Seville made significant contributions to the effort. Mr. Dennis Wightman of the Naval Training Equipment Center served as Contracting Officer's Technical Representative. The assistance of Canyon Research Group, Inc., the VTRS support contractor, and its personnel is gratefully acknowledged, as is the support provided by personnel at Squadrons VT-9 and VT-19 at Meridian Naval Air Station; VT-4 at Pensacola NAS; Hq., CNET; and Hq., CNATRA.

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I. INTRODUCTION

BACKGROUND

The Naval Training Equipment Center (NAVTRAEQUIPCEN) has developed a comprehensive visual simulation research facility.[1] The Visual Technology Research Simulator, or VTRS, is a major component of the facility. It is intended for use in the investigation of visual simulation technology, particularly investigation of simulation questions peculiar to naval aviation. The VTRS is intended for research in both engineering technology and in training. Thus, it is intended to help advance both the simulation state-of-the-art and the effectiveness with which flight simulation is used operationally in present and future naval aviation training. A major thrust of the research activity with the VTRS to date has been the assessment of the effects on training for critical Navy flight tasks of variations in selected visual system parameters.

The most distinguishing feature of Navy flying, and one of the most demanding tasks Navy pilots perform, is landing safely aboard an aircraft carrier. Carrier qualification (CQ) is thus a critical stage of both undergraduate and graduate training programs. While a night carrier landing trainer (NCLT)[2] has been employed successfully for several years by Fleet aviators in the A-7 community, visual simulators have not been used[3] for initial CQ training in the Navy's Jet Undergraduate Pilot Training (JUPT) program. Through a series of research efforts, the VTRS is being used to investigate visual system design requirements needed to support undergraduate CQ training and, thus, to aid in remedying this lack of JUPT simulation support.

Previous research activities with the VTRS have sought to reduce the large number of possibly significant simulation design variables to more manageable levels. This has been accomplished through a series of screening studies with the VTRS[4] and a joint study with the USAF Human Resources

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[1]Collyer, S. C., & Chambers, W. S. AWAVS, a research facility for defining flight trainer visual system requirements. Proceedings of the 22nd Annual Meeting of the Human Factors Society, Detroit, October 1978.

[2]Brictson, C. A., & Burger, W. J. Transfer of training effectiveness: A7E Night Carrier Landing Trainer (NCLT), Device 2F103 (NAVTRAEQUIPCEN Tech. Rep. 75-C-0105-1). Orlando, FL: Naval Training Equipment Center, August 1976.

[3]Device 2B35 is a visual device used in Navy JUPT. While it has the capability for simulating the carrier landing task, it is not used for that purpose in Navy JUPT.

[4]Westra, D. P., Simon, C. W., Collyer, S. C., & Chambers, W. S. Investigation of simulator design features for the carrier landing task (NAVTRAEQUIPCEN Tech. Rep. 78-C-0060-7). Orlando, FL: Naval Training Equipment Center, 1981.

Laboratory using that service's Advanced Simulator for Pilot Training (ASPT).[1] The results of these studies indicated that pilots could indeed learn to perform the carrier landing task in the simulator under a variety of simulator and training conditions. However, it has remained to be shown whether such simulator training would transfer to the actual aircraft and, if so, the effects of various simulator design and/or training variables on such transfer. The present report describes a limited scale pilot study carried out as part of the first phase of a two-phase research effort designed to address these transfer of training concerns. A full report of Phase I of the effort is given in a separate document,[2] but an overview of the entire study is given below to further the reader's understanding of the pilot study reported herein.

OVERVIEW OF THE TRANSFER OF TRAINING STUDY

The statement of work (SOW) for the effort called for an experiment to assess the effects of simulator visual system variables as they bear upon the performance of the day carrier landing task in the T-2 phase of Navy Jet Undergraduate Pilot Training. The training effects of selected visual system variables having implications for the cost of simulators (e.g., day versus night computer image generation, wide versus narrow field of view) would be examined in a transfer of training experiment using the VTRS as the training vehicle and the T-2 aircraft as the transfer test vehicle.

The goals of Phase I of the effort were to develop a suitable transfer study experimental design and to conduct a pilot study to assess the feasibility of that design for use in Phase II. Phase II, at the government's option, would consist of the conduct of a full scale experiment utilizing the design developed in Phase I.

The conduct of any transfer of training experiment involving aviators undergoing JUPT requires some degree of advance assurance that none of the conditions will jeopardize the students' progress through training. Further, such research must be minimally disruptive to ongoing training practices, policies, and schedules. In addition, the research procedures must be sound if interpretable results are to be obtained. It was to provide information on concerns such as these that the pilot study reported here was undertaken. Other Phase I activities, aside from the pilot study itself, dealt with such concerns as planning and coordination, the definition of independent variables (i.e., simulator visual parameters), training scenario preparation, performance measurement, and data collection and analysis. These latter activities are described more fully in the overall Phase I report.[3]

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[1]Collyer, S. C., Ricard, G. L., Anderson, M., Westra, D. P., & Perry, R. A. Field of view requirements for carrier landing training (NAVTRAEQUIPCEN IH-319/AFHRL-TR-80-10). Orlando, FL: Naval Training Equipment Center, June 1980.

[2]Isley, R. N., Spears, W. D., Prophet, W. W., & Corley, W. E. VTRS transfer of training experiment: Phase I--experimental design (Seville Tech. Rep. TR 82-02). Pensacola, FL: Seville Research Corporation, January 1982.

[3]Isley et al., op. cit.

PURPOSE OF THE STUDY

The pilot study was conducted in pursuit of three major goals: (1) to explore the feasibility of use of various VTRS experimental variables with Navy JUPT trainees; (2) to determine which computer generated performance assessment measures should be of primary concern; and (3) to assess the logistic and administrative problems associated with training Student Naval Aviators (SNAs) in the VTRS.

Feasibility of Experimental Variables

Through earlier Phase I activities the list of potential simulator variables to be assessed was reduced to two levels of each of the following:

1. Brightness of scene (day versus night);

2. Field of view (wide versus narrow);

3. Scene content (field scene versus carrier scene); and

4. Type of approach (circling or full pattern versus straight-in).

Variables 1 and 2 concern simulator hardware design and are significant cost drivers in visual system procurement. For example, a day scene with a wide field of view would be more expensive than a night scene and/or a narrow field of view. Variables 3 and 4 primarily relate to training concerns, but could influence the choice of hardware under some circumstances. Several technical and procedural questions associated with these latter variables arose during the Phase I planning activities, and they were included in the pilot study in order to develop additional information concerning their appropriateness for use in the Phase II full scale experiment. These questions and their resolutions are discussed in the companion overall Phase I report.[1]

Performance Assessment Concerns

An automated performance assessment program developed for use in previous Navy VTRS studies was adapted for use in the VTRS in the present effort. For the pilot study it was anticipated that the data from the performance assessment program would be useful in examining such things as skill acquisition rate, the number of trials needed per experimental session, and the number of experimental sessions needed in the simulator. In addition, it was of interest to determine which parameters, among the many being monitored, provided the best indices of student performance. By identifying parallels between VTRS and aircraft performance measures, it was expected that the pilot study would also help identify appropriate measures for use in FCLP and CQ.

Logistic and Administrative Concerns

In this category the pilot study was intended to assess questions concerning the transport of JUPT students to Orlando for VTRS training during the

[1] Isley et al., op. cit.

Phase II effort in a fashion that would minimize disruption of ongoing training activities in the JUPT squadron. Of concern were such questions as:

- How can transportation between the training base and the VTRS best be handled?
- How many trainees can be cycled through the simulator per a given unit of time?
- Will a Landing Signal Officer (LSO) be needed at the VTRS to monitor trainee performance and provide feedback?
- Will the rate of simulator availability support the level of sustained training operations required by the Phase II design?

The pilot study reported here sought to answer as many of these questions as possible. The information thus obtained was used in developing the recommended experimental design[1] for the full scale experiment to be carried out in Phase II.

ORGANIZATION OF THIS REPORT

There are three sections to this report, including the present introduction. Section II describes the approach to the pilot study. Section III reports the results and summarizes the implications of the findings for the goals of Phase I of the study and for the transfer of training experiment to be proposed for Phase II. In addition, Appendix A contains various simulator training-related procedures and materials used in the pilot study. Appendix B contains performance data for simulator training, FCLP, and CQ for the Student Naval Aviators who served as subjects in the study.

[1]The design is described in the overall Phase I report previously cited.

II. APPROACH

SIMULATOR TRAINING CONDITIONS

As noted, the primary goals of the pilot study were to clarify concerns in three main areas: (1) experimental variables to be used during Phase II; (2) performance measures to be used; and (3) logistics and administration of the Phase II experiment. The pilot study was thus exploratory in nature and not intended to provide information concerning effects of simulator training conditions per se and transfer of VTRS training to the T-2 aircraft. Instead, it was required in order to ensure that none of the conditions being considered for use in Phase II would be detrimental to the participating SNAs. That is, it was desired to identify any simulator training condition which might interfere with or otherwise negatively affect student performance in the aircraft. This meant that "worst case" combinations[1] of variables should used in the pilot study along with less questionable combinations.

Of sixteen possible combinations of two levels on the four variables c sidered, the eight combinations selected for the pilot study were as follo

	Scene Content	Brightness	Field of View	Type of Approac
1.	field	day	wide	full
2.	field	day	wide	straight-in
3.	field	night	narrow	full
4.	field	night	narrow	straight-in
5.	carrier	day	wide	full
6.	carrier	day	wide	straight-in
7.	carrier	night	narrow	full
8.	carrier	night	narrow	straight-in

Descriptions of the levels of each variable follow.

1. Scene content: The visual display is a full color, wide angle computer generated real image presented on a spherical screen with a 10 foot radius. One type of scene content, the landing field scene, is modeled after Runway 01 and environs at Meridian Naval Air Station, Meridian, Mississippi. A target projector was used to superimpose carrier deck markings on the end of the runway. The other scene content, the carrier scene, was modeled after the USS Forrestal (CVA-59) and is superimposed on a background seascape.

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[1] "Worst case" is used here as describing those combinations of simulator variables or conditions that would appear to have lowest face validity when compared with the operational task situation, e.g., use of a night scene to train for a day operational task.

2. Brightness of scene: Day brightness levels were 4.0, 0.6, and 0.85 foot lamberts for ship, sea, and sky, respectively, and night levels were 0.04 foot lamberts for background illumination and 0.8 for the carrier deck. There is no horizon in the night scene.

3. Field of view: The wide field of view provided a -30° to +50° vertical by ± 80° horizontal field. The narrow field of view, achieved by covering portions of the full scene, provided a -27° to +9° vertical by ± 24° horizontal field.

4. Type of approach: The full pattern or circling approach began at 600 feet altitude on the downwind leg of the pattern. The simulated aircraft was located one mile left of the carrier (or field) and approximately ten seconds prior to the abeam-of-the-LSO position on the carrier (or field). The straight-in approach began at 400 feet altitude and two miles from the end of the field or carrier. However, to force the pilot to acquire the approach envelope, the simulated initial position was to the left of proper line-up with the center line of the landing area, and heading was 20° to the right of final approach.

SUBJECTS

For purposes of the pilot study, the Navy provided eight Student Naval Aviators (SNAs) drawn from two Intermediate training squadrons (VT-9 and VT-19) at Meridian Naval Air Station. The only constraints placed on subject selection were that foreign nationals be excluded, that all subjects have no more than approximately 80 hours in the T-2 aircraft, and that all subjects be scheduled to begin FCLP training immediately following VTRS training in preparation for carrier qualification in December, 1981. Eight SNAs meeting these constraints were supplied by the Wing Landing Signal Officer (LSO) at Meridian, and they were randomly assigned by the investigator, one to each of the conditions listed earlier. The SNA assigned to the sixth condition in the list could not be available, however, for last minute reasons beyond experimenter control. The other seven SNAs were flown to and from Orlando via Navy aircraft in two groups approximately two and one-half days apart. A squadron LSO was also assigned to each group.

TRAINING PROCEDURES

Each subject was scheduled to receive three training periods in the VTRS under his assigned condition, although due to difficulties with the VTRS, three SNAs completed only two training periods each. Each training period consisted of 16 approaches (trials) and required approximately 45-50 minutes to complete. Each approach began with the simulator flying straight and level in a landing configuration (i.e., wheels, flaps, and hook down, speed brake out) with 15 units angle of attack (AOA) and 85% power.[1] The approach was continued to touchdown or waveoff, following which the simulator was automatically frozen and re-set for the next trial. During and at the end of each

[1] For field approaches, the hook is not lowered.

trial, appropriate feedback was provided to the SNA via radio by the assigned LSO who monitored the approach from the simulator operator's console.[1] For a more detailed list of simulator training conditions and LSO, SNA and VTRS console operator tasks, see Appendix A.

Prior to the start of the first VTRS training session the SNAs were briefed by a member of the project staff on the overall purpose of the experiment, provided with a copy of the anticipated training schedule, and given a short task list outlining the procedures to be followed during each approach. The assigned LSO then briefed the SNAs on the approach pattern to be flown and the appropriate communications procedures to be followed. After completing the briefing session the SNA entered the simulator cockpit, established radio contact with the console operator and the LSO, activated the g-seat, and, when ready to begin the approach, requested the console operator to unfreeze the trainer. During the trial the LSO monitored the approach, responded to all radio calls from the cockpit, and provided typical LSO coaching messages based on the SNA's performance. At the end of each trial the LSO critiqued the SNA's performance, offered suggestions for the next trial, and completed the LSO grading form shown in Appendix A. Each trial required an average of approximately 1.25 minutes, with an average inter-trial interval of approximately 1.5 minutes during which time the trial data were stored in the computer, the simulator reset for the next trial, and the LSO critique given.

During the periods that the SNAs were not flying the VTRS, they participated in an exploratory research effort under the direction of Canyon Research Group, the VTRS support contractor. The Canyon effort involves the potential use of performance scores obtained from video games as a covariate in aviation training research studies. Between simulator periods the SNAs practiced on two such video games under a protocol developed by Canyon. Although this data collection was in conjunction with the pilot study reported here, the Canyon effort is an independent study and is not commented on further in this report.

MEASUREMENT OF PERFORMANCE

Computer printouts provided a variety of cumulative and "snapshot" data from which measures of performance in the simulator could be derived. The data used in analyses reported in the next section, which were derived from these printouts, covered both the approach pattern and touchdown performance. These data are described in greater detail in the next section.

In addition to the data on performance in the VTRS, data were to be collected describing SNA performance during FCLP and CQ subsequent to VTRS training.

[1] From this position the LSO was able to monitor aircraft instrument readings via a CRT display, observe a TV monitor of the visual scene being presented to the SNA, and also monitor a graphic CRT display of the changes in AOA, lineup, power, and glideslope.

III. RESULTS AND DISCUSSION

The results of the pilot study as they relate to the three areas of concern are presented below.[1] Performance assessment is discussed first, because what was found provided an important criterion --evidence of skill integration-- for assessing the feasibility of possible independent variables for the Phase II experiment. The feasibility of these variables is treated next, followed by a discussion of results that clarify logistic and administrative concerns. Finally, there is a summary discussion of the implications of the findings for the Phase II experiment. The implications are discussed more fully in the companion overall Phase I report, in which the results of the pilot study can be viewed in the perspective of the broader range of Phase I activities.

PERFORMANCE ASSESSMENT

For each simulator trial, computer printouts provided a record of the aircraft approach path as well as a number of measures of the status and motion of the simulated aircraft at touchdown. The touchdown measures included (1) longitudinal distance from a reference point (e.g., end of the carrier); (2) roll attitude; (3) pitch attitude; (4) lateral deviation from the center line of the landing area; (5) vertical velocity; and (6) angle of attack. In addition, an indication was provided of whether or not a "trap" resulted and, if so, which wire was caught. While these data sets worked well with the carrier scene, there was a question regarding the accuracy of the measures for the field scene. It appears that additional debugging of the field scene performance measurement system is needed. (Recall that the carrier deck outline of the carrier scene had been imposed on the field; and there were apparently still some difficulties with the "fit.")

As for the carrier scene, no consistent patterns of improvement were found as far as the touchdown measures were concerned. Examination of other printout data provided an explanation. Of special value in this regard were percents of times in tolerance for glideslope, angle of attack (AOA), and lateral deviation (line-up) at various stages of the simulated approach. Fortunately, these data were usable for the field as well as the carrier scene.

A consistent pattern across subjects was observed in these data. In most cases, percents of time in tolerance for glideslope, AOA, and line-up correlated negatively with one another at a given stage of the approach during the early trials, but positively during later trials. This was also true of correlations for a single aspect across stages within trials. It appeared, thus, that pilots at first concentrated on glideslope or AOA or line-up from trial to trial as well as shifting attention from stage to stage within a given trial. Later, all three variables tended to receive attention at the same time.

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[1] Because of the small number of subjects involved, inability to secure complete data on all subjects, and the postponement of the December carrier qualification trials, the data gathered are somewhat fragmentary in nature. Therefore, discussions in this chapter are of an overall summary nature rather than being in the nature of a detailed exposition of the data. Appendix B contains the actual data and statistical summarizations thereof.

This inference was supported by plots of these percentages against trials. For pilots who flew straight-in approaches, the typical pattern was for performance on one variable, say, AOA, to be quite high during the first five trials, with that for glideslope and line-up being relatively (or actually) low. The separation would be reduced slightly for a few trials, and then the divergence would increase through trials 23-27. Then, percents in tolerance would converge for the three variables. However, at convergence, performance had typically "deteriorated" on the originally high variable, and often one other. After convergence, the performance eventually improved, but usually on all three variables simultaneously.

Pilots who flew circling approaches followed a similar pattern, except that performance on no single variable was particularly high at the outset. The plotted curves rapidly diverged, however, and then converged, as was the case with the pilots who flew straight-in approaches.

The consistency of these patterns--the divergence of performance across variables followed by convergence; the fact that performance invariably "deteriorated" substantially on at least one variable to accomplish convergence; the joint improvement on all variables following convergence--implies that skill integration was occurring. This conclusion is supported by analogous, often nonmonotonic changes in magnitudes of control inputs for throttle and aileron, and perhaps for elevator.

These findings have important implications for measures of performance during FCLP. For example, certain day-to-day inconsistencies in measures of FCLP performance that were observed prior to the pilot study raised questions regarding the practicality of obtaining meaningful measures of performance quality. Following the pilot study, these inconsistencies were re-examined. It was found that indicators of skill integration in FCLP parallel those found in the VTRS computer printouts, inconsistencies and all. Hence, problems of measuring FCLP performance are resolved to a considerable extent. The problems, and their resolutions, are discussed in detail in the overall Phase I report.

While the context for the comment is still freshly in mind, it should be mentioned that the integrated performance as indicated by computer printouts did not improve substantially following integration. The curves had begun to climb by the end of the 48 trials, but overall average performance was generally no better than early in practice. (Recall that ostensible deterioration usually had occurred in at least one skill parameter, so at original integration, overall performance in most cases was relatively low.) For this reason, simulator practice during the Phase II experiment should probably continue for 64 trials, 16 more than the 48 used during the pilot study, in order to provide additional opportunity for this integrated skill to mature or stabilize.

FEASIBILITY OF EXPERIMENTAL VARIABLES

Insofar as the pilot study was concerned, issues examined regarding experimental variables related only to their feasibility for meaningful and safe utilization during the Phase II experiment. Can both levels of each variable be implemented in conjunction with each level of the other variables? Are pilots able to adapt to the separate simulator configurations soon enough and in a manner that progress occurs? Is there danger of negative training? As explained earlier, "worst case" combinations of variables were included to ensure identifying problems.

With reference to the performance of the seven SNAs during their FCLP training subsequent to their VTRS training, it can be stated that all completed FCLP without apparent difficulty; only one student received a "down" grade on any hop.[1] Unfortunately, their actual carrier landing qualification (CQ-11X) hop did not take place as scheduled. The December boat was canceled due to mechanical problems aboard the USS Lexington that prevented its going to sea. Therefore, these seven students had to begin their FCLP workup all over again in preparation for the January 1982 boat date. All seven students qualified on the January boat.

Their percent "OK" scores during FCLP showed evidence of learning over the CQ-3-10 hops.[2] However, as noted earlier, having only one subject per condition provided no reasonable basis for estimating the amount of transfer that might be associated with any of the various simulator training conditions. Further, there were only three other students in the same December boat group, so constituting a meaningful control group for comparison purposes was not feasible. However, as noted, none of the students experienced any undue difficulty in his FCLP, so no real evidence can be adduced to suggest that any of the simulator training conditions represents a true "worst case" to be avoided in Phase II insofar as FCLP performance is concerned. There were, however, certain problems in SNA performance in the simulator that raise questions concerning use of one of the potential variables during Phase II. These questions are treated in the following discussion of the various simulator variables as they relate to Phase II.

The first variable discussed, field versus carrier scene, was the only one where difficulties were found. It is discussed first, because its difficulties account for those encountered with the other three variables, full pattern versus straight-in approach, wide versus narrow field of view, and day versus night scene.

Field Versus Carrier Scene

Because of the interpolation of FCLP between simulator training and CQ, the original plan was to use a field scene during simulator practice for half of the Phase II experimental subjects. The expectation was that transfer effects of simulator practice would be most apparent in the next training activity, FCLP, so the scene should be as similar as practical to the actual visual conditions for FCLP. However, the quality of the field scene appeared too poor for meaningful practice. One subject who used it with a full pattern approach was not able to get into position for a meaningful final approach on

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[1] One "down" hop from among seven SNAs (70 hops) is not unusual.

[2] Student scores for FCLP training, shown in Appendix B, reflect only the December, 1981 hops. Data for the January FCLP hops were not available; however, data for the January CQ-11X hop are included in Appendix B.

30 of his 32 trials.[1] A second subject using the field scene showed no evidence either of overall improvement or of skill integration (see Performance Assessment), even though he used a straight-in approach. A third subject showed overall improvement with the field scene using a wide FOV and a full approach. The "improvement," however, was due to an originally very low performance on all aspects of the approach that developed to moderate performance on AOA and line-up. Glideslope showed little improvement. The fourth subject who used the field scene with a straight-in approach, wide field of view, completed only 32 trials. Final performance was no better than original performance, though it seemed that some skill integration had occurred.

The conclusion to be drawn is that the field scene should not be used during the Phase II experiment unless its quality is improved substantially. At least two of the four SNAs who practiced with it experienced undue difficulties. In addition, it will be recalled that there was some difficulty with the automated measurement program for the field scene.

Full Versus Straight-in Approach

For overall simulator conditions that resulted in observable progress, no important differences were found between performances of pilots who used the full approach and those who used the straight-in approach. As might be expected, however, there were some differences in the earliest trials. Pilots who flew straight in were usually superior on at least one variable, glideslope, AOA, or line-up, for the first 16 trials. However, those using the full approach not only caught up, they seemed to have a more stable integration of these three variables, especially as they neared touchdown, once the separate performance curves converged. The fact that no two pilots had the same overall set of simulator conditions makes meaningful interpretation of the minor differences in integration trends impossible. Suffice it to say that unless other variables, specifically the field scene/night conditions, were also present, the full approach presented no observable hardship to the pilots. The straight-in approach with field scene/night conditions did not appear to be successful either.

Wide Versus Narrow Field of View

As anticipated, field of view (FOV) remains a viable variable. That is, the results of the pilot study revealed no difficulty with narrow versus wide FOV for experimental comparisons that cannot be readily accounted for through the effects of the field scene. Specifically, difficulties arose only when the narrow FOV was used in conjunction with the field scene and a night condition. The subject who, with these conditions, had a full approach accomplished little in the 32 trials he had available. Another subject with these conditions, but with a straight-in approach, showed no task integration in 48 trials. Yet, the narrow FOV and night conditions were no problem when the carrier scene was used, regardless of the nature of the approach.

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[1] Three subjects (design conditions 2, 3, and 7) were able to complete only 32 trials due to operating problems with the VTRS.

The only remaining issue regarding FOV as a variable concerns the full approach with which it might be coupled. Can a pilot using a circling approach with a narrow FOV find the carrier, especially in time to follow through with a normal landing approach? A positive answer seems clear. The subject in the pilot study who had carrier-night-narrow FOV-circling conditions missed a reasonable approach only one time, and that was on the first trial.

Day Versus Night Scene

The condition of day versus night scene was also found to be viable for the Phase II experiment. As with FOV, difficulties arose only when the field scene was used. (The nature of the difficulties has been identified in discussions of the field versus carrier scenes and of circling versus straight-in approaches.) Given that the field scene will be eliminated from consideration, no further difficulties with day or night conditions are anticipated.

LOGISTIC AND ADMINISTRATIVE CONCERNS

The basic question here concerned how best to cycle SNAs through the VTRS in a fashion that would minimize training time away from the squadron, yet allow efficient use of the VTRS. Since there is only one T-2 cockpit available in the VTRS, only one SNA can be trained at a time. During the pilot study, it appeared that processing SNAs in groups of four was optimal. Larger groups would cause interperiod intervals of such magnitude that SNAs likely would become bored while awaiting their next simulator session. Limiting the number of SNAs to four at a time complicates the transportation schedule for ferrying SNAs between Orlando and their home squadron, but would tend to minimize per diem costs. At the same time, restriction of the days available in Orlando per SNA will require a high rate of availability for training in the VTRS. Simulator training periods lost due to maintenance problems may not be recoverable, i.e., an SNA may have to return to his squadron before completing all scheduled periods. Indeed, this occurred during the pilot study, and, as noted, three SNAs were limited to only 32 trials instead of the 48 originally scheduled. Because similar difficulties may arise during the Phase II experiment, it will be necessary to allow for replacements of subjects who are unable to complete VTRS training.

Another administrative concern addressed in the pilot study was whether or not a squadron LSO was really needed at the VTRS to monitor SNA training and provide feedback over trials. Both of the LSOs who participated in the pilot study felt their presence was, indeed, needed, especially during early simulator trials. They recorded SNA performance utilizing the data form shown in Appendix A and found it useful in connection with providing feedback to the SNAs between trials.

All in all, the pilot study revealed no logistic or administrative problems that would prevent a successful experiment during Phase II. Conduct of Phase II will, of course, require close coordination among the agencies involved and sufficient flexibility in the research design to accommodate unanticipated perturbations in JUPT training schedules and VTRS availability. The Phase II research plan recommended in the overall Phase I report takes these concerns into account.

SUMMARY OF IMPLICATIONS

Performance Assessment

From the standpoint of VTRs training, the most important finding of the pilot study was the consistent evidence that various skills involved in approaches to the carrier became integrated. VTRS practice did not continue long enough for the integrated pattern as a whole to reach a high level of performance; but the lack of being at a high level, together with the patterns with which integration developed, account for the irregular, at times chaotic, variations in touchdown qualities so evident in computer printouts. From the standpoint of possible transfer, it is the skill integration--the behavioral process--that is important. With sufficient integration, proper touchdowns will occur as a matter of course. They are not likely in any degree of consistency until integration has progressed.

As explained in the companion overall Phase I report, the pattern of integrative development not only justifies what had been a tentative choice of a performance measure, it indicates that measure is the most appropriate indicator of early overall skill development that is conveniently available. As a corollary, the explanation implies a need for a measure of touchdown accuracy--wire caught on the carrier and wire equivalent in FCLP. Measures of proper line-up at touchdown are also needed. A suitable procedure involving runway reference points has been developed for FCLP use in Phase II. (If it were feasible, which it will not be for the Phase II experiment, FCLP measures of dynamic status of the aircraft would be valuable as well.)

An additional implication is the probable need for 64 rather than 48 training trials in the VTRS. Skill integration began half way, usually more, through the 48 trials, and it did so at some sacrifice of overall level of performance. Improvement in performance following initial integration was thus limited by the lack of sufficient additional practice. Trends in the data suggest that an additional 16 trials could make a difference in what a pilot takes with him to FCLP.

Feasibility of Experimental Variables

Of the four variables examined during the pilot study, only the field scene posed a problem. Thus, all Phase II subjects should use the carrier scene. Both "levels" of each of the remaining three variables are viable--wide versus narrow field of view, day versus night scene, full pattern versus straight-in approach.

Logistic and Administrative Concerns

The constraints imposed by Navy training schedules, transportation requirements, and VTRS availability, though considerable, can be accommodated through careful and continuous coordination throughout the Phase II effort. It is believed that such coordination can be effected and maintained under the research plan described in the overall Phase I report.

APPENDIX A

PILOT STUDY VTRS TRAINING PROCEDURES

This appendix lists various tasks, functions, and conditions pertinent to the Phase I pilot study. Included are: (1) a list of tasks describing LSO activities related to VTRS training; (2) performance records of simulator training trials completed by the LSO; (3) a list of procedural tasks for the SNAs; (4) a list of VTRS console operator functions; and (5) a description of the eight VTRS training conditions that were used.

LSO VTRS TRAINING TASKS

The LSO will:

1. Be generally responsible for SNA activities during the VTRS training, e.g., transportation, billeting, training schedules, and instruction.

2. Ensure that all SNAs have read the four FCLP/CQ programmed texts and received the appropriate briefings prior to the first VTRS training period.

3. Brief SNAs on the appropriate VTRS training activities covering the following:

   (a) VTRS training will consist of 3 VTRS periods of approximately 45 minutes each, using the Meridian (field) or carrier scene depending on group assignment.

   (b) Brief SNAs on the specific training tasks, how they will be done in the VTRS, and visual conditions for their performance (FOV, scene content, day/night).

   (c) At the beginning of each pass, the aircraft will be positioned either downwind just prior to the abeam position, or short of the straight-in position and in a landing configuration.

   (d) The SNA will enter the cockpit and perform the NATOPS Landing Checklist. When he is ready to commence the FCLP or CQ pass, he will so advise the LSO via radio. The console operator will then unfreeze the simulator and the SNA will fly the approach.

   (e) The SNA will make the normal abeam radio report (with the night, narrow FOV, and full pattern, wait approximately 10 seconds after the VTRS is unfrozen).

   The SNA will commence the turn at the 180° position based on 15 knots wind at Meridian and 25 knots at the carrier (full pattern).

   (g) Groups using the narrow FOV in a full pattern approach will not have visual contact with the scene until about 15 degrees prior to roll out on final and will have to make the turn and initiate the descent on instruments.

   (h) The SNA will pickup the FLOLS approaching final and make the "ball call" report.

   (i) The SNA will make power and line-up corrections as necessary; the LSO will make instructional comments to assist the SNAs in flying the correct track.

(j) Shortly after the FCLP touch and go or the carrier trap or bolter, the simulated aircraft will automatically be frozen and, after a few seconds, will be repositioned to the initial downwind or straight-in position for another trial. During this break the LSO will critique the SNA as necessary.

(k) The SNA will continue making FCLP or CQ trials until he has completed 16 trials, which is estimated to require about 50 minutes.

4. The LSO will monitor the training activities from the right side of the VTRS console, using the radio to communicate with the SNA and the CRT displays to monitor performance. (The VTRS Console Operator will perform initial condition set-up, data storing, and reset simulator functions.)

5. The LSO will record an evaluation of each pass on the form provided using standardized LSO grading procedures. He may also record additional comments, as necessary to assist in debriefing.

SNA VTRS PERFORMANCE RECORD

NAME ______________________ SQD # ______________________

LSO ______________________ DATE ______________________

SCENE ______________________ GROUP/FLIGHT # ______________________

TRIAL NO.	LSO EVALUATION
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	

COMMENTS: ______________________

SNA PROCEDURES

1. Complete NATOPS Before Landing Checklist.

2. Make "UNFREEZE" request when ready to fly.

*3. Perform downwind procedures.

*4. Make abeam report.

*5. Identify 180° position/wind effect.

6. Make approach turn.

7. Arrive "at-the-start" straight-in position.

8. Call the ball.

9. Scan:

   (a) AOA control.

   (b) Ball control.

   (c) Line-up.

10. Perform touch and go landing (FCLP) or trap/bolter (carrier).

   (a) Console operator will reposition trainer to downwind or straight-in position after each landing.

   (b) The SNA will complete 16 passes each training period.

   (c) LSO will critique each pass.

*Full pattern approaches only.

CONSOLE OPERATOR TASKS

Set-Up Requirements

1. Load or ensure Meridian scene (ship's FLOLS @ 3.25°) or carrier scene (FLOLS @ 4°) is loaded according to SNA's group assignment.

2. Ensure that narrow FOV equipment is installed if required per SNA's group assignment.

3. Setup VTRS initial conditions per SNA's group assignment:

   A. Scene Content

      (1) Meridian - Groups A and B

      (2) Carrier - Groups C and D

   B. Brightness

      (1) Day - Groups A and C

      (2) Night - Groups B and D

   C. FOV

      (1) Wide - Groups A and C

      (2) Narrow - Groups B and D

   D. Approach Pattern Initial Position

      (1) Full pattern - Groups A_1, B_1, C_1, and D_1

      (2) Straight-in - Groups A_2, B_2, C_2, and D_2

   E. Sound - 100%

   F. Wind - 15 knots down the runway or 25 knots down the angle deck

   G. Rough air - .5 and/or sea state zero

   H. Motion - OFF

   I. G-seat - ON

   J. Initial position - downwind (600 AGL, AOA 15 units, 85% power, etc.) for those groups with a one (1) subscript; or just prior the straight-in (400 AGL, AOA 15 units, just prior to intercepting the FLOLS datum, etc.) for those groups with a two (2) subscript.

   K. Fuel - 2250 Lbs

Tasks During Training

1. Log SNA's identification number, trial number, and date.

2. Unfreeze VTRS when SNA is ready to start the training.

3. Store data after each trial (transfer and print data as necessary).

4. Reposition the aircraft to downwind or straight-in after data are stored; advise SNA regarding initial position each time so he will know precisely where he is in the pattern.

5. Operate VTRS controls as necessary.

6. Communicate with SNA as necessary. (The LSO will provide instructional comments to the SNA.)

VTRS TRAINING CONDITIONS

Condition	Description
A_1	Meridian, day scene, wide FOV, and 180° landing approach. VTRS motion off, g-seat pressurized, wind 15 knots down the runway (01), sound at 100%, and no rough air. Prior to each trial, the simulated T-2 was positioned (FROZEN) on the downwind leg 10 seconds prior to the abeam position with all systems operating normally and set-up in the landing configuration, i.e., 600 ft. AGL; 15 units AOA; gear, flaps, and speed brakes down and out; 2250 lbs. fuel. The trial began when the VTRS was UNFROZEN and ended shortly after touchdown or waveoff.
A_2	Meridian, day scene, wide FOV, and straight-in approach. The conditions described for A_1 above applied except that the simulated T-2 aircraft was positioned (FROZEN) 2 miles out from touchdown, positioned left of centerline, heading 20° right of approach course, at 400 ft. AGL prior to each trial.
B_1	Meridian, night scene, narrow FOV, and 180° landing approach. The other conditions described for A_1 applied.
B_2	Meridian, night scene, narrow FOV, and straight-in approach. The other conditions described for A_2 applied.
C_1	Carrier, day scene, wide FOV, and 180° landing approach. The other conditions described for A_1 applied, except that the wind down the angle deck (350°) was 25 knots and the sea condition was zero.
C_2	Carrier, day scene, wide FOV, and straight-in approach. The other conditions described in A_2 applied, except the wind and sea state were as noted for C_1.
D_1	Carrier, night scene, narrow FOV, and 180° landing approach. The other conditions described in C_1 applied.
D_2	Carrier, night scene, narrow FOV, and straight-in approach. The other conditions described in C_2 applied.

APPENDIX B

PILOT STUDY PERFORMANCE DATA

This appendix presents performance data for the subjects in the pilot study. Most data relate to performance in the simulator, but there are in addition measures of performance during Field Carrier Landing Practice (FCLP) and Carrier Qualification trials.

SIMULATOR PERFORMANCE

Trial-by-trial computer printouts provided a variety of data from which a number of measures of performance were derived. This appendix summarizes two sets of measures which illustrate most directly the interpretations discussed in Section III: (1) touchdown accuracy; and (2) coordination of control of glideslope, angle of attack, and line-up.

Touchdown Accuracy

Tables B-1 through B-6 present measures of touchdown accuracy separately for the six subjects for whom data were usable. (The seventh subject, who flew a night scene, narrow field of view (FOV), circling approach to the simulated FCLP field, had usable data on only 2 of 32 trials.) The data are grouped in sets of 16 trials, representing performance during 16-trial sessions. The separate subjects, each of whom flew under a different set of simulator conditions, are identified in the table titles by their set of conditions, to wit, the scene brightness (day or night), size of FOV (wide or narrow), approach pattern (straight-in or circling), and the landing area (carrier or field).

There are six principal types of measures represented in tables for those who had the carrier scene; and although touchdown measures for the field scene were questionable, five such measures are included (see below for the one omitted). All measures are reported as deviations from ideal values, so zero would indicate ideal performance in each case. The symbols that represent the measures are as follow:

X longitudinal deviation, i.e., in the direction of flight, of touchdown from ideal touchdown point. The deviation is in "wire" units, with zero representing a touchdown that would normally engage wire #3. 1 indicates that wire #4 would have been caught, -1 wire #2, -2 wire #1, etc. Although there are only four wires on a carrier, multiples of the "wire" unit (distance between second and third wire) were included for all touchdowns. A score of 5 would indicate, for example, a touchdown 5 wire units beyond wire #3, a -5 a similar number of units short of wire #3.

Note that longitudinal touchdown values (Xs) are not given for the field scene. Vagaries in these data made them especially questionable.

R amount of roll at touchdown, measured in degrees (zero roll ideal). Sign of the measure differentiates left versus right roll.

P amount of pitch deviation in degrees from an ideal pitch of 8.7 degrees. Negative values indicate less than 8.7 degrees, positive values more than 8.7 degrees.

Y lateral deviation in feet from an ideal line-up, i.e., touching down in the center of the runway. The ideal value is zero; signs indicate deviations to one side or the other.

VV amount of deviation of vertical velocity at touchdown from an ideal value of -8.1 feet per second. Deviations are given in feet per second.

AOA amount of deviation of angle of attack, in AOA units, from an ideal value of 15 units. Negative values indicate less than 15 units, positive values more.

In addition to these tables, means for successive blocks of trials of four trials each appear in Tables B-7 through B-12. Superscripts a and b indicate, respectively, that only two, or three, trials yielded usable data for that block. The blocks are further divided into groups of four, representing the 4 x 4 = 16 trials during any one practice session.

Means are given separately for sums of algebraic values (including sign) and absolute values (considering all scores positive). The absolute means are, of course, better measures of accuracy because positive and negative values cancel each other, in some cases yielding a mean "error" of zero when every trial had an error. Nevertheless, the algebraic means could have revealed systematic errors that might have implied that something about the simulator or the scene caused the errors. There might have been some transitory systematic errors, but if so the systematic aspect was overcome.

There are certain patterns in the data that are especially pertinent. First, improvement across all 48 trials (or 32 for some subjects) did not occur on more than four measures for any pilot, and only three pilots showed any general improvement (in most cases not statistically significant). Two of the three had the carrier scene, one with straight-in and one with a circling approach. The third subject had the field scene and circling approach, but with a day, wide FOV condition. None of the other three subjects with the field scene showed improvement. Indeed, one had no usable data at all, and another nc usable data for the first 16 trials.

A second thing to notice is the regularity with which one measure or another, often multiple measures, increase from one four-trial block to another through the first few blocks. A better picture of what is going on is provided in the next section which first presents data on the last 1000 feet of the approach that establishes the "setup" for touchdown.

TABLE B-1. TOUCHDOWN MEASURES FOR PILOT WHO FLEW A DAY, WIDE, CIRCLING APPROACH TO CARRIER

Trial	X	R	P	Y	VV	AOA
1	*	*	*	*	*	*
2	-1	4.3	1.4	7	1.2	1.7
3	8	-10.1	0.9	9	1.9	3.3
4	-2	9.1	0.6	15	-0.2	1.5
5	-3	4.7	0.4	-7	3.8	2.1
6	3	-5.0	2.1	13	1.1	3.4
7	*	*	*	*	*	*
8	-4	2.8	2.6	-11	1.2	3.5
9	*	*	*	*	*	*
10	*	*	*	*	*	*
11	-4	0.5	1.1	-10	3.0	3.0
12	3	-1.5	0.1	-25	7.6	4.3
13	5	1.9	1.9	-14	3.9	5.1
14	-3	4.1	-1.7	-7	8.1	3.3
15	-2	0.1	3.2	-1	-1.8	2.6
16	-3	3.0	1.8	-20	8.5	7.1
17	2	2.8	1.4	4	3.5	3.3
18	6	-1.0	1.1	8	1.0	1.5
19	3	-5.7	0.3	0	1.0	1.7
20	-3	4.3	2.0	-19	4.5	3.6
21	-6	1.9	-0.4	-11	4.0	1.6
22	0	10.3	-2.5	5	0.4	-4.0
23	1	-2.1	2.5	3	5.8	5.0
24	-6	0.4	-1.3	4	-10.2	-6.1
25	-1	-2.0	2.5	0	-2.3	1.9
26	3	-1.1	3.0	-18	-1.5	2.3
27	2	3.7	0.9	13	0.1	1.1
28	0	1.9	-0.3	-8	3.3	0.7
29	*	*	*	*	*	*
30	-1	3.2	1.1	2	2.5	1.8
31	0	1.4	0.7	15	-0.6	1.0
32	4	0.9	1.9	13	-4.3	0.6
33	*	*	*	*	*	*
34	-1	-1.0	0.5	15	3.3	2.5
35	3	0.7	0.5	16	0.7	0.6
36	-1	-0.8	1.6	8	-1.5	1.7
37	*	*	*	*	*	*
38	1	1.3	-2.6	7	3.6	-1.1
39	1	0.9	-1.0	-9	1.6	0
40	*	*	*	*	*	*
41	*	*	*	*	*	*
42	3	2.0	-1.0	-25	2.6	0.4
43	3	2.0	2.4	8	-3.0	2.1
44	-2	-2.6	1.7	5	0.4	2.8
45	-1	1.5	1.7	-2	-1.8	1.7
46	-2	-1.6	0.1	6	2.6	1.8
47	-1	-0.3	0.5	-5	2.3	2.2
48	-6	-0.9	4.3	-26	3.5	6.7

*Trial did not yield usable touchdown data.

TABLE B-2. TOUCHDOWN MEASURES FOR PILOT WHO FLEW A NIGHT, NARROW, STRAIGHT-IN APPROACH TO CARRIER

Trial	X	R	P	Y	VV	AOA
1	*	*	*	*	*	*
2	2	-9.1	1.0	-52	2.5	2.9
3	*	*	*	*	*	*
4	3	8.4	-7.2	-15	11.8	-2.1
5	-6	0.7	0.6	25	-9.1	-2.9
6	0	1.8	-5.8	12	13.2	-1.9
7	-3	13.1	-4.3	1	13.9	-0.3
8	6	-8.5	-1.3	0	-3.5	-1.8
9	2	-3.5	-4.2	-24	7.9	-0.8
10	-1	-10.9	-3.0	-5	6.6	-0.5
11	10	-1.6	-2.8	0	2.1	-0.7
12	0	2.7	-2.3	-18	2.2	-1.6
13	5	-7.8	-6.3	-12	5.5	-4.8
14	-1	1.0	-4.1	-6	5.8	-1.7
15	-4	4.7	-4.3	-12	4.6	-3.1
16	-2	1.2	-2.1	-10	6.1	-0.6
17	0	2.8	-4.4	-7	5.3	-3.3
18	-5	-0.7	-0.2	-11	-0.8	-0.6
19	-2	3.9	-0.8	1	-2.1	-1.2
20	*	*	*	*	*	*
21	2	4.5	-5.1	3	5.3	-3.8
22	-6	1.3	-1.4	-21	1.4	-2.3
23	4	-9.0	-2.5	-38	7.9	1.0
24	1	-6.3	-3.9	-15	5.5	-1.8
25	-4	3.6	-2.9	6	7.7	-0.4
26	-4	2.0	1.1	-16	-5.6	-1.2
27	-2	-2.6	-4.7	-19	7.9	-2.1
28	-4	4.0	-0.1	2	1.1	-0.1
29	-4	3.8	-1.3	-1	0.3	-1.2
30	6	8.7	-3.4	20	-1.0	-3.0
31	-1	-1.3	-3.2	1	2.8	-2.5
32	-2	4.7	-2.1	1	2.8	-1.5
33	-3	3.5	-4.4	-14	8.6	-1.4
34	1	2.0	-5.4	-15	6.9	-3.4
35	0	5.6	-2.9	0	-1.3	-3.7
36	2	3.5	-2.3	1	-1.4	-3.0
37	0	6.6	-3.1	4	2.8	-2.3
38	2	7.9	-1.9	13	0	-1.9
39	-3	5.8	-1.9	-2	2.6	-0.9
40	3	3.3	0.4	0	-4.7	-1.1
41	0	1.5	-3.3	-10	1.7	-2.9
42	-1	2.8	-4.1	-10	6.6	-1.8
43	-6	-4.1	2.4	-20	-4.3	1.1
44	-2	-1.0	-4.9	-12	7.8	-2.3
45	1	-1.4	-4.1	-15	7.0	-1.4
46	1	4.5	-1.4	-6	-2.5	-2.4
47	-5	2.6	-0.6	8	2.0	0.6
48	-1	-0.7	-3.3	-5	1.3	-3.2

*Trial did not yield usable touchdown data.

TABLE B-3. TOUCHDOWN MEASURES FOR PILOT WHO FLEW A NIGHT, NARROW, CIRCLING APPROACH TO CARRIER

Trial	X	R	P	Y	VV	AOA
1	*	*	*	*	*	*
2	2	1.2	-2.7	-4	2.7	-1.8
3	4	-1.1	-1.7	15	3.4	0
4	4	0.5	-2.2	-7	-2.7	-3.1
5	5	0.1	-2.4	13	1.0	-2.2
6	*	*	*	*	*	*
7	-6	-0.8	0.9	-23	1.7	1.9
8	1	-2.4	0.8	-14	-1.0	1.4
9	-6	3.4	5.1	16	-3.9	4.1
10	6	-1.1	0	3	1.9	1.6
11	*	*	*	*	*	*
12	0	0.4	-0.6	10	1.0	-0.1
13	0	0.3	0.6	-10	1.1	0.9
14	7	-1.3	-0.1	-11	-2.7	-0.3
15	3	-1.9	0.6	-8	2.5	2.2
16	-3	0.7	1.5	-11	-3.6	-0.2
17	3	-1.1	0.1	-17	6.3	0.6
18	9	0.9	-1.9	-1	2.4	-1.1
19	2	3.2	-0.5	10	1.8	1.2
20	0	-0.7	-1.4	2	2.2	0.4
21	-3	2.0	2.6	23	1.8	2.7
22	2	-2.8	-1.1	12	4.7	2.4
23	-2	-2.0	3.3	2	0.6	5.0
24	5	-0.6	-1.7	-13	5.8	1.1
25	0	0	2.5	-7	-4.8	0.9
26	8	-0.5	0.1	7	0.2	1.7
27	1	4.9	0.1	24	1.1	0.2
28	-2	-0.7	1.8	-11	1.5	2.9
29	-3	6.5	3.6	-6	-3.3	2.2
30	3	-0.1	-1.3	0	0.5	0.6
31	10	-2.8	2.4	12	-1.2	2.6
32	4	1.4	0.2	1	8.3	4.3

*Trial did not yield usable touchdown data.

TABLE B-4. TOUCHDOWN MEASURES FOR PILOT WHO FLEW A DAY, WIDE, CIRCLING APPROACH TO FIELD[1]

Trial	R	P	Y	VV	AOA
17	-0.7	-1.2	-3	4.3	0.8
18	0	0.8	3	-1.9	0.2
19	0.2	-6.5	0	7.1	-4.1
20	0.9	-1.3	-2	2.2	0
21	1.2	-3.6	12	9.1	-0.1
22	-2.9	-3.6	8	0.8	-4.1
23	2.5	-6.3	-1	7.1	-5.1
24	*	*	*	*	*
25	-5.1	-2.0	5	2.8	-1.0
26	-0.6	0.3	-4	1.6	0.9
27	-4.2	-0.8	2	-0.1	0.4
28	4.4	-4.1	9	4.9	-2.5
29	-2.3	-2.8	12	0.7	-2.5
30	-5.7	-5.3	-4	5.2	-3.6
31	7.8	-3.4	10	1.0	-3.8
32	-1.5	-1.9	-10	0.9	-0.8
33	1.0	1.3	-5	-1.0	1.6
34	0.7	1.1	-2	-0.6	1.5
35	2.3	0.9	2	-1.0	1.0
36	1.2	1.2	2	0.2	1.8
37	1.2	-3.1	-2	5.8	-0.8
38	6.9	-1.7	6	2.6	-0.6
39	4.0	-0.5	4	-0.2	-0.6
40	3.9	1.7	5	-1.0	1.9
41	1.4	-0.4	-1	0.3	0.1
42	1.9	-1.9	-1	1.3	-1.3
43	2.6	-0.8	0	2.1	0.3
44	2.1	0.1	3	-3.0	-0.9
45	0.9	-1.8	-5	2.3	-0.8
46	-1.5	-0.4	0	1.7	0.7
47	3.3	-1.9	2	5.0	0.3
48	-0.6	-2.6	10	1.3	-2.2

[1]Only two of the first 16 trials yielded usable touchdown data.

*Trial did not yield usable touchdown data.

TABLE B-5. TOUCHDOWN MEASURES FOR PILOT WHO FLEW A DAY, WIDE, STRAIGHT-IN APPROACH TO FIELD

Trial	R	P	Y	VV	AOA
1	2.2	3.6	-37	-6.3	2.2
2	*	*	*	*	*
3	-2.6	2.4	-7	-3.9	2.1
4	*	*	*	*	*
5	1.8	3.9	-9	3.4	6.8
6	-1.2	2.9	-4	-6.4	1.5
7	*	*	*	*	*
8	2.6	-0.9	5	2.5	1.2
9	-1.8	0.2	-13	-2.0	0.3
10	0.3	2.3	-3	-0.3	2.3
11	-0.9	-0.8	-2	-1.9	-1.3
12	*	*	*	*	*
13	-2.6	3.6	-21	-3.5	2.6
14	-1.4	-0.3	-15	-3.7	-0.9
15	-1.5	2.2	-6	0.5	3.6
16	-1.9	0.9	-13	-2.5	0.7
17	*	*	*	*	*
18	-0.6	0.4	23	2.3	1.3
19	-4.0	-0.3	12	1.4	0.2
20	0.4	-0.9	4	1.6	-0.1
21	-1.1	-4.8	23	6.3	-2.5
22	1.6	1.1	6	1.1	2.9
23	0.9	0.2	9	-0.1	0.4
24	-0.7	-2.6	-2	2.4	-1.0
25	*	*	*	*	*
26	0	-3.6	2	3.3	-2.2
27	*	*	*	*	*
28	-2.1	5.6	20	0.9	-2.2
29	-0.2	-3.3	11	4.9	-1.3
30	4.3	-6.3	6	7.2	-2.2
31	4.9	0.1	-3	-2.1	0.1
32	2.3	-1.6	11	2.6	0.3

*Trial did not yield usable touchdown data.

TABLE B-6. TOUCHDOWN MEASURES FOR PILOT WHO FLEW A NIGHT, NARROW, STRAIGHT-IN APPROACH TO FIELD

Trial	R	P	Y	VV	AOA
1	-0.3	2.0	-29	-5.9	0.7
2	2.5	-1.0	-10	-4.8	-2.0
3	4.2	-2.0	2	4.2	1.0
4	0.5	-3.6	-3	6.7	-0.8
5	1.5	-2.4	C	-0.1	-1.9
6	4.6	-3.2	2	4.1	-1.3
7	-2.4	-4.2	-3	5.3	-2.6
8	2.7	-2.6	-13	1.9	-1.1
9	3.6	-4.2	0	6.1	-1.4
10	1.4	-4.4	-16	4.6	-2.3
11	1.9	-3.7	-4	5.0	-2.1
12	1.3	-0.6	3	1.0	1.2
13	3.4	-4.8	-2	3.9	-3.8
14	2.3	-5.0	-5	3.1	-3.7
15	3.9	-5.5	0	5.2	-3.3
16	1.2	-6.1	10	6.8	-3.3
17	1.6	-5.6	-6	9.4	-3.8
18	-1.7	-4.1	18	4.2	-3.3
19	0.6	-3.6	-6	5.0	-1.7
20	0.4	-5.4	-15	6.2	-2.9
21	0.7	-5.5	11	5.1	-3.7
22	*	*	*	*	*
23	1.7	-3.3	-23	4.5	-1.6
24	1.3	-4.5	-7	5.6	-2.0
25	-0.3	-0.9	-9	2.9	1.0
26	0.3	-4.4	-30	5.0	-2.1
27	-0.8	-0.4	-22	1.1	1.2
28	0.4	-3.9	-24	5.8	-1.1
29	-1.2	-3.3	-3	2.4	-1.9
30	-0.6	1.0	28	-5.2	-0.1
31	-0.7	-5.7	-14	7.8	-3.2
32	2.5	-7.0	6	4.1	-5.6
33	0.5	-1.5	22	3.5	-0.1
34	0.5	1.2	-6	-4.9	-0.3
35	0.9	-4.3	-3	4.7	-2.7
36	4.3	-1.5	-15	0.5	-1.1
37	1.7	-3.2	0	7.5	-0.5
38	2.6	-1.9	-2	0.7	-1.6
39	1.5	-5.8	5	8.7	-3.1
40	0.7	-4.1	7	0.8	-4.2
41	1.5	2.6	30	0.5	3.0
42	0.7	-0.5	17	3.8	1.2
43	-0.1	-0.7	-15	3.1	0.9
44	-1.3	1.3	-13	-4.5	-1.1
45	2.4	-0.9	26	2.6	0.4
46	1.9	-3.8	-9	3.1	-3.1
47	-3.0	-2.7	-20	5.7	-0.4
48	-0.6	2.1	20	-3.6	1.3

TABLE B-7. TOUCHDOWN MEASURES FOR PILOT WHO FLEW A DAY, WIDE, CIRCLING APPROACH TO CARRIER

Trial Block	Algebraic Mean						Absolute Mean					
	X	R	P	Y	VV	AOA	X	R	P	Y	VV	AOA
1-4[b]	1.7	1.1	1.0	10.3	1.0	2.2	3.7	7.8	1.0	10.3	1.1	2.2
5-8[b]	-1.3	0.8	1.7	-1.7	2.0	3.0	3.3	4.2	1.7	10.3	2.0	3.0
9-12[a]	-0.5	-0.5	0.6	17.5	5.3	3.6	3.5	1.0	0.6	17.5	5.3	3.6
13-16	-0.8	2.3	1.3	-10.5	4.7	4.5	3.2	2.3	2.2	10.5	5.6	4.5
17-20	2.0	0.1	1.2	-1.8	2.5	2.5	3.5	3.4	1.2	7.8	2.5	2.5
21-24	-2.8	2.6	-0.4	0.2	0.0	-0.9	3.2	3.7	1.7	5.8	5.1	4.2
25-28	1.0	0.6	1.5	-3.2	-0.1	1.5	1.5	2.2	1.7	9.8	1.8	1.5
29-32[b]	1.0	1.8	1.2	10.0	-0.8	1.1	1.7	1.8	1.2	10.0	2.5	1.1
33-36[b]	0.3	-0.4	0.9	13.0	0.8	1.6	1.7	0.8	0.9	13.0	1.8	1.6
37-40[a]	1.0	1.1	-1.9	-1.0	2.6	-0.5	1.0	1.1	1.9	8.0	2.6	0.5
41-44[b]	1.3	0.8	1.0	-4.0	0.0	1.8	2.7	2.2	1.7	12.7	2.0	1.8
45-48	-2.5	-0.3	1.6	-6.8	1.6	3.1	2.5	1.1	1.6	9.8	2.6	3.1
1-16	-0.2	0.9	1.2	3.9	3.2	3.3	3.4	3.8	1.4	12.2	3.5	3.3
17-32	0.3	1.3	0.9	1.3	0.4	1.0	2.5	2.8	1.4	8.4	3.0	2.3
33-48	0.0	0.2	0.4	0.3	1.2	1.5	2.0	1.3	1.5	10.9	2.2	1.8

TABLE B-8. TOUCHDOWN MEASURES FOR PILOT WHO FLEW A NIGHT, NARROW, STRAIGHT-IN APPROACH TO CARRIER

Trial Block	Algebraic Mean						Absolute Mean					
	X	R	P	Y	VV	AOA	X	R	P	Y	VV	AOA
1-4[a]	2.5	-0.4	-3.1	-33.5	7.2	0.4	2.5	8.7	4.1	33.5	7.2	2.5
5-8	-0.8	1.8	-2.7	9.5	3.6	-1.7	3.8	6.0	3.0	9.5	9.9	1.7
9-12	2.8	-3.3	-3.1	-11.8	4.7	-0.9	3.2	4.7	3.1	11.8	4.7	0.9
13-16	-0.5	-0.2	-4.2	-10.0	5.5	-2.6	3.0	3.7	4.2	10.0	5.5	2.6
17-20[b]	-2.3	2.0	-1.8	-5.7	0.8	-1.7	2.3	2.5	1.8	6.3	2.7	1.7
21-24	0.2	-2.4	-3.2	-17.5	5.0	-1.7	3.2	5.3	3.2	19.0	5.0	2.2
25-28	3.5	1.8	-1.6	-6.8	2.8	-1.0	3.5	3.0	2.2	10.8	5.6	1.0
29-32	-0.2	4.0	2.5	5.2	1.2	-2.0	3.2	4.6	2.5	5.8	1.7	2.0
33-36	0.0	3.6	-3.8	-7.0	3.2	-2.9	1.5	3.6	3.8	7.5	4.6	2.9
37-40	0.5	5.9	-1.6	3.8	0.2	-1.6	2.0	5.9	1.8	4.8	2.5	1.6
41-44	-2.2	0.2	-2.5	-13.0	3.0	-1.5	2.2	2.4	3.7	13.0	5.1	2.0
45-48	-1.0	1.2	-2.4	-4.5	2.0	-1.6	2.0	2.3	2.4	8.5	3.2	1.9
1-16	1.0	-0.5	-3.3	-11.4	5.2	-1.2	3.1	5.8	3.6	16.2	6.8	1.9
17-32	0.3	1.4	-1.0	-6.2	2.4	-1.6	3.0	3.8	2.4	10.5	3.8	1.7
33-48	-0.7	2.7	-2.6	5.2	2.1	-1.9	1.9	3.6	2.9	8.4	3.8	2.1

TABLE B-9. TOUCHDOWN MEASURES FOR PILOT WHO FLEW
A NIGHT, NARROW, CIRCLING APPROACH TO CARRIER

Trial Block	Algebraic Mean X	R	P	Y	VV	AOA	Absolute Mean X	R	P	Y	VV	AOA
1-4[a]	3.3	0.2	-2.2	1.3	1.1	-1.6	3.3	0.9	2.2	8.7	2.9	1.6
5-8[a]	0.0	-1.0	-0.2	-8.0	0.6	0.4	4.0	1.1	1.4	16.7	1.2	1.8
9-12[a]	0.0	0.9	1.5	9.7	-0.3	1.9	4.0	1.6	1.9	9.7	2.3	1.9
13-16	1.8	-0.6	0.6	10.0	-0.8	0.6	3.2	1.0	0.7	10.0	2.5	0.9
17-20	3.5	0.6	-0.9	-1.5	3.2	0.3	3.5	1.5	1.0	7.5	3.2	0.8
21-24	0.5	-0.8	0.8	6.0	3.2	2.8	3.0	1.8	2.2	12.5	3.2	2.8
25-28	1.8	0.9	1.1	3.2	-0.5	1.4	2.8	1.5	1.1	12.2	1.9	1.4
29-32	3.5	1.2	1.2	1.8	1.1	2.4	5.0	2.7	1.9	4.8	3.3	2.4
1-16	1.3	-0.1	-0.1	3.2	0.2	0.3	3.6	1.2	1.6	11.3	2.2	1.6
17-32	2.3	0.5	0.6	2.4	1.8	1.7	3.6	1.9	1.6	9.2	2.9	1.8

TABLE B-10. TOUCHDOWN MEASURES FOR PILOT WHO FLEW
A DAY, WIDE, CIRCLING APPROACH TO FIELD

Trial Block	Algebraic Mean R	P	Y	VV	AOA	Absolute Mean R	P	Y	VV	AOA
1-16	*	*	*	*	*	*	*	*	*	*
17-20	0.1	-2.0	-0.5	2.9	-0.8	0.4	2.4	2.0	3.9	1.3
21-24[b]	0.3	-4.5	6.3	5.7	-3.1	2.2	4.5	7.0	5.7	3.1
25-28	-1.4	-1.6	3.0	2.1	-0.6	3.6	1.8	5.0	2.1	1.2
29-32	-0.4	-3.4	2.0	2.0	-2.7	4.3	3.4	9.0	2.0	2.7
33-36	1.3	1.1	-0.8	-0.6	1.5	1.3	1.1	2.8	0.7	1.5
37-40	4.0	-0.9	3.2	1.8	0.0	4.0	1.8	4.2	2.4	1.0
41-44	2.0	-0.8	0.2	0.2	-0.4	2.0	0.8	1.2	1.7	0.6
45-48	0.5	-1.7	1.8	2.6	-0.5	1.6	1.7	4.2	2.6	1.0
17-32	-0.4	-2.9	2.7	3.2	-1.8	2.6	3.0	5.8	3.4	2.1
33-48	2.0	-0.6	1.1	1.0	0.2	2.2	1.4	3.1	1.8	1.0

* Only two trials, numbers 9 and 13, yielded usable data among the first 16 trials.

TABLE B-11. TOUCHDOWN MEASURES FOR PILOT WHO FLEW A DAY, WIDE, STRAIGHT-IN APPROACH TO FIELD

Trial Block	Algebraic Mean R	P	Y	VV	AOA	Absolute Mean R	P	Y	VV	AOA
1-4[a]	-0.2	3.0	-22.0	-5.1	2.2	2.4	3.0	22.0	5.1	2.2
5-8[b]	1.1	2.0	-2.7	-0.2	3.2	1.9	2.6	6.0	4.1	3.2
9-12[b]	-0.8	0.6	-6.0	-1.4	0.4	1.0	1.1	6.0	1.4	1.3
13-16	-1.9	1.6	-13.8	-2.3	1.5	1.9	1.8	13.8	2.6	2.0
17-20[b]	-1.4	-0.3	13.0	1.8	0.5	1.7	0.5	13.0	1.8	0.5
21-24	0.2	-1.5	9.0	2.4	0.0	1.1	2.2	10.0	2.5	1.7
25-28[a]	-1.0	1.0	11.0	2.1	-2.2	1.0	4.6	11.0	2.1	2.2
29-32	2.8	-2.8	6.2	3.2	-0.8	2.9	2.8	7.8	4.2	1.0
1-16	-0.4	1.8	-11.1	-2.2	1.8	1.8	2.1	12.0	3.3	2.2
17-32	0.2	-0.9	9.8	2.4	-0.6	1.7	2.5	10.4	2.6	1.4

TABLE B-12. TOUCHDOWN MEASURES FOR PILOT WHO FLEW A NIGHT, NARROW, STRAIGHT-IN APPROACH TO FIELD

Trial Block	Algebraic Mean R	P	Y	VV	AOA	Absolute Mean R	P	Y	VV	AOA
1-4	1.7	-1.2	-10.0	0.0	-0.3	1.9	2.2	11.0	5.4	1.1
5-8	1.6	-3.1	-3.5	2.8	-1.7	2.8	3.1	4.5	2.8	1.7
9-12	2.0	-3.2	-4.2	4.2	-1.2	2.0	3.2	5.8	4.2	1.8
13-16	2.7	-5.4	0.8	4.8	-3.5	2.7	5.4	4.2	4.8	3.5
17-20	0.2	-4.7	-2.2	6.2	2.9	1.1	4.7	11.2	6.2	2.9
21-24[b]	1.2	-4.4	-6.3	5.1	-2.4	1.2	4.4	13.7	5.1	2.4
25-28	-0.1	-2.4	-21.2	3.7	-0.2	0.4	2.4	21.2	3.7	1.4
29-32	0.0	-3.8	4.2	2.3	-2.7	1.2	4.2	12.8	4.9	2.7
33-36	1.6	-1.5	-0.5	1.0	-1.0	1.6	2.1	11.5	3.4	1.0
37-40	1.6	-3.8	2.5	4.4	2.4	1.6	3.8	3.5	4.4	2.4
41-44	0.2	0.7	4.8	0.7	1.0	0.9	1.3	18.8	3.0	1.6
45-48	0.2	-1.3	4.2	2.0	-0.4	2.0	2.4	18.8	3.8	1.3
1-16	2.0	-3.2	-4.2	3.0	-1.7	2.4	3.5	6.4	4.3	2.0
17-32	0.3	-3.8	-6.4	4.3	-0.6	1.0	3.9	14.8	5.0	2.4
33-48	0.9	-1.5	2.8	2.0	0.5	1.5	2.4	13.2	3.6	1.6

Coordination of Control

Computer printouts also provided percents of time in tolerance for several parameters of flight during segments of the approach. Although magnitudes of various control inputs are of interest, the interest derives from their relation to three particular variables: percents of time in tolerance for glideslope (GS), angle of attack (AOA), and line-up with the center line of the runway (LU). Subsequent discussions will focus on these three.

First, Table B-13 shows how these percents for the last 1000 feet of approach each correlate with the sequence of trial numbers within eight-trial blocks. For a given variable, GS, AOA, or LU, for example, the percent of time in tolerance on the first trial of the block is paired with the number of the first trial (i.e., 1); percent of time in tolerance on the second trial is paired with the number two; etc. through eight trials. Correlations between these paired values will be positive if percent of time in tolerance is generally greater for later trials in the block than for earlier trials. If performance deteriorates during a block, the correlation will be negative. Overall progress or lack thereof is indicated by correlations in the last column of Table B-13 which treats all 48 (or 32 for some subjects) as a single block. Eight trials, rather than four as before, were used so as to provide greater stability for the correlations. (Nevertheless, note that the trials included in any case are not a sample, but a universe. Instability of correlations derives not from the number per se of trials, but from nondeterminable variations in the subjects' performance.) The correlations, Pearson rs, are given separately for each pilot whose flight conditions are identified by the sequence of letters in the left-most column. The first letter (C or F) indicates carrier or field; the second (D or N) day or night scene; the third (N or W) narrow or wide FOV; and the fourth (C or S) a circling or straight-in approach.

One thing to notice about the pattern of rs is the frequency of negative values early in training, meaning that performance deterioriated during the eight-trial block. A second thing to notice is the high frequency of negative and near-zero rs as late as trials 25-32. Detailed examination of the data showed that on these trials the subjects were beginning to show basic integration of control of GS, AOA, and LU if they were to show much at all. As discussed in Section III, performance often deteriorated on some aspects while others "caught up." Then, performance on two or all three improved (note positive rs for trials 41-48 for both "carrier" subjects who had this many trials).

Figures B-1 through B-6 clarify this point. The curves in these figures, which represent percents in tolerance for GS, AOA, and LU for the last 6000 feet of approach, show integration patterns in the perspective of a longer segment of the approach. The divergence of curves, followed by convergence in which at least one skill suffered apparent degradation, is clearly apparent for all pilots except the subject who flew night, narrow, straight-in approaches to the field. His curves never converged, nor was any overall progress apparent.

TABLE B-13. CORRELATIONS (X 100) OF GLIDESLOPE (GS), ANGLE OF ATTACK (AOA), AND LINE-UP (LU) WITH SUCCESSIVE TRIALS WITHIN BLOCKS

	Trial Block						
	1-8	9-16	17-24	25-32	33-40	41-48	1-48
CNNS:							
GS	46	-16	36	-11	02	31	53
AOA	-44	-05	-02	-34	60	18	32
LU	-17	-68	-55	-02	10	32	02
CDWC:							
GS	52	31	42	-02	-06	64	27
AOA	43	48	23	10	-49	56	33
LU	-01	-38	16	29	-59	01	05
CNNC:							
GS	66	-02	41	-72			-14[a]
AOA	61	04	72	-47			25[a]
LU	05	-74	-17	-44			00[a]
FDWC:							
GS	*	*	-61	-33	37	-33	-02[b]
AOA	*	*	-40	-26	-27	12	38[b]
LU	*	*	24	-01	33	-37	25[b]
FDWS:							
GS	-20	-71	43	64			00[a]
AOA	-76	38	-21	24			-13[a]
LU	64	09	45	50			44[a]
FNNS:							
GS	80	-12	58	10	-04	-33	22
AOA	-43	-78	48	-82	63	-52	01
LU	60	18	04	30	56	28	-6

*No correlations could be computed for first 16 trials because only two trials yielded usable data.

[a]Total correlation based on only 32 trials.

[b]Because of unusable data for first 16 trials, correlation is based on trials 17-48.

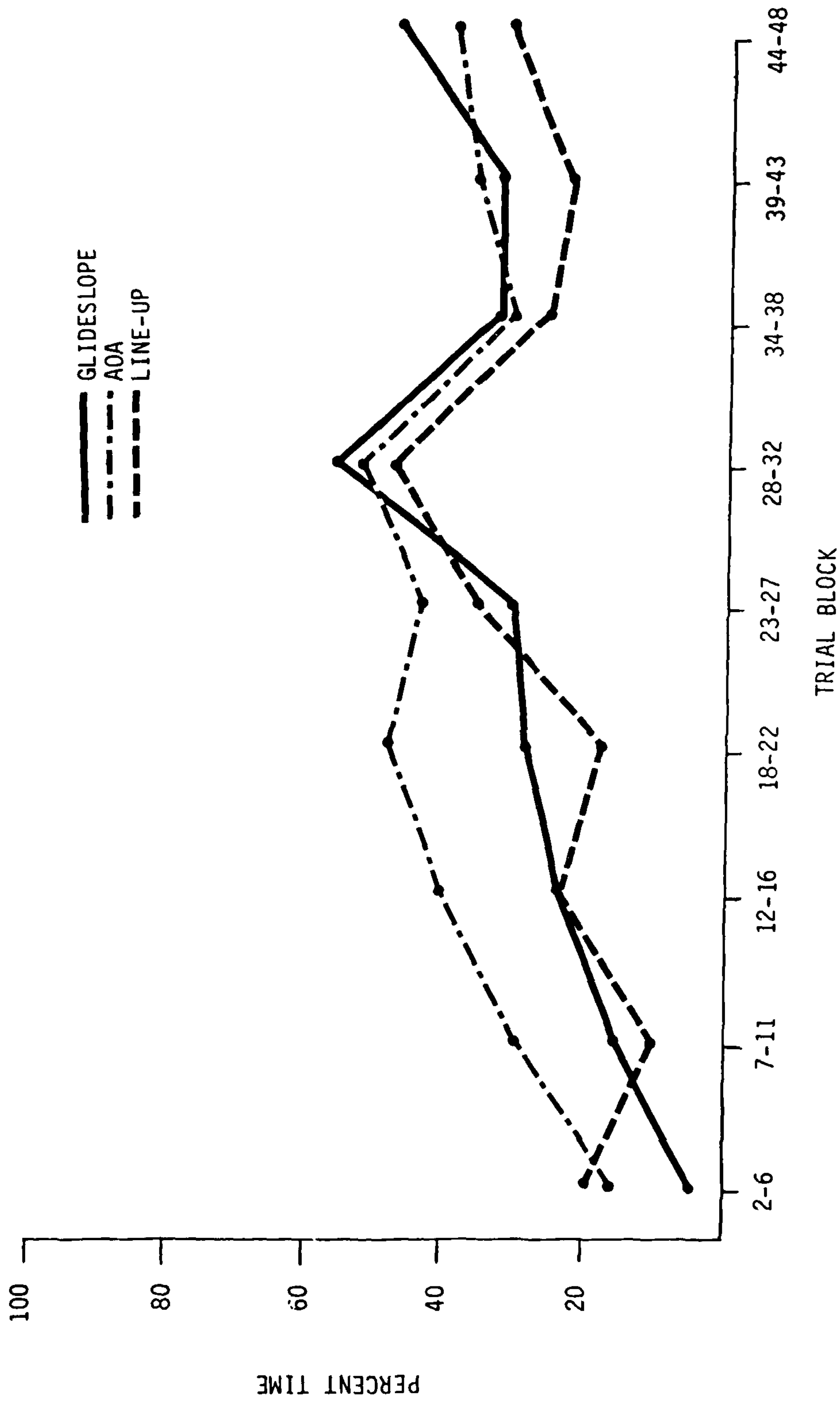

FIGURE B-1. PERCENT OF TIME IN TOLERANCE BY TRIAL BLOCK DURING LAST 6000 FEET OF A DAY, WIDE, CIRCLING APPROACH TO CARRIER.

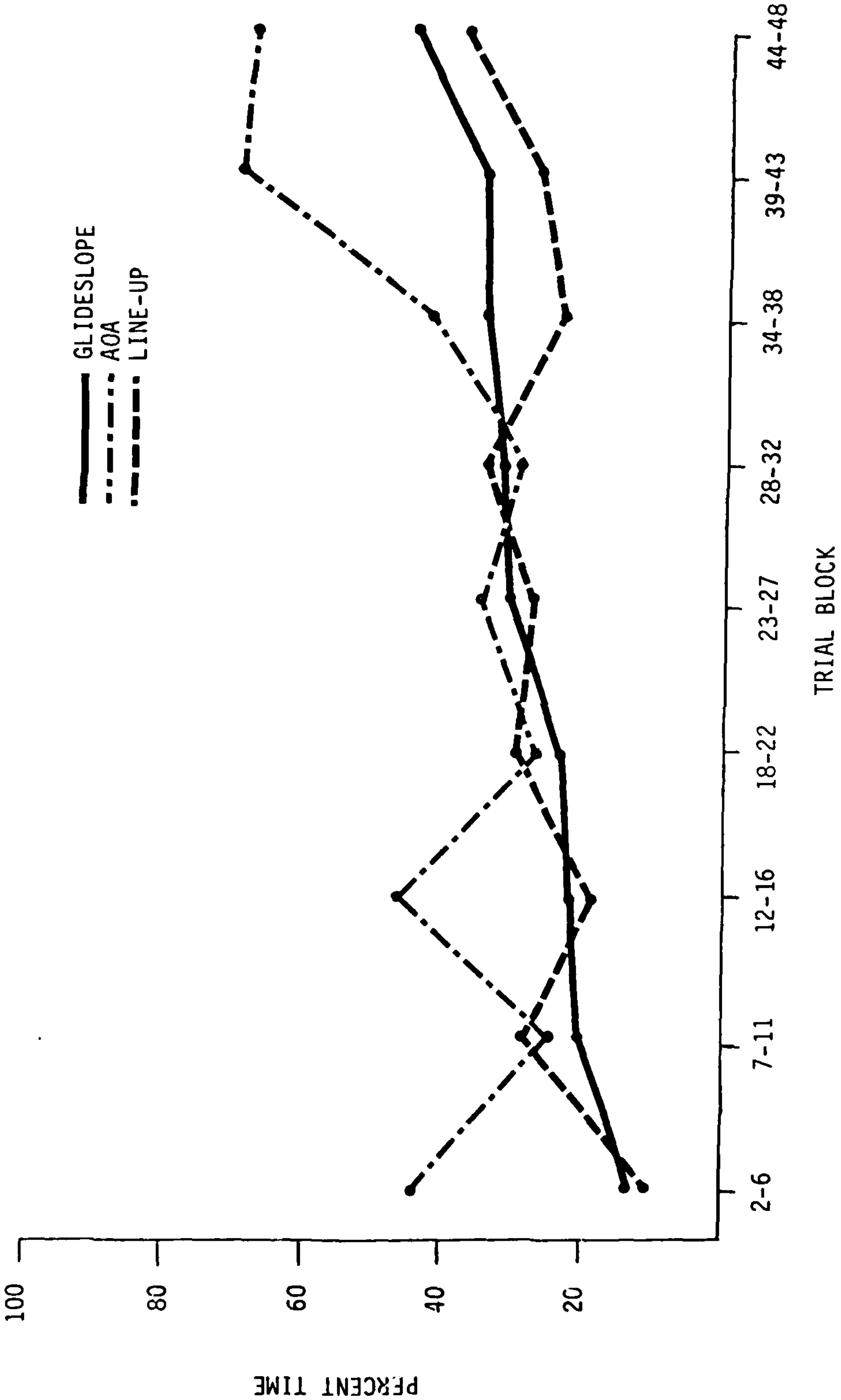

FIGURE B-2. PERCENT OF TIME IN TOLERANCE BY TRIAL BLOCK DURING LAST 6000 FEET OF A NIGHT, NARROW, STRAIGHT-IN APPROACH TO CARRIER.

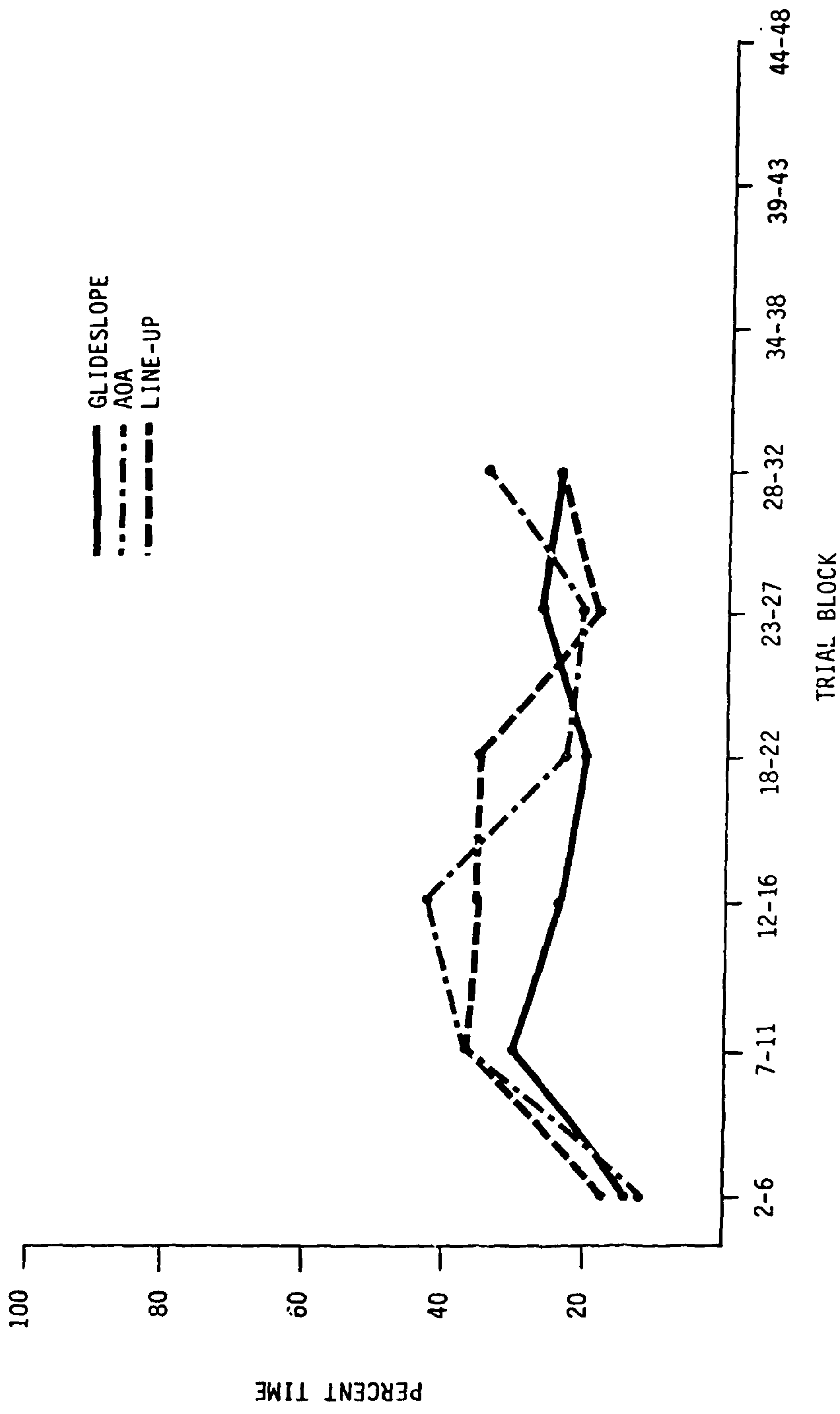

FIGURE B-3. PERCENT OF TIME IN TOLERANCE BY TRIAL BLOCK DURING LAST 6000 FEET OF A NIGHT, NARROW, CIRCLING APPROACH TO CARRIER.

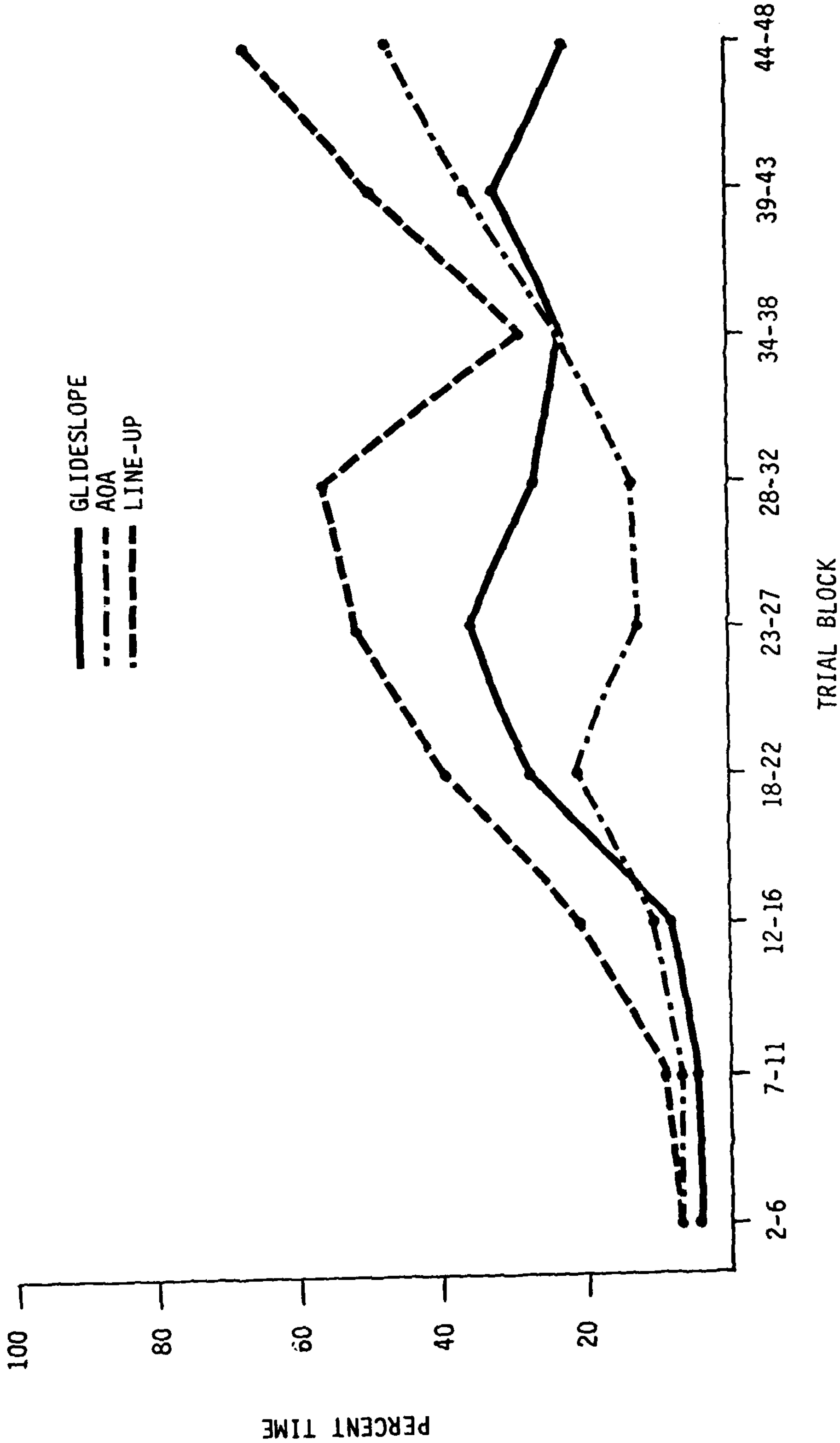

FIGURE B-4. PERCENT OF TIME IN TOLERANCE BY TRIAL BLOCK FOR LAST 6000 FEET OF A DAY, WIDE, CIRCLING APPROACH TO FIELD.

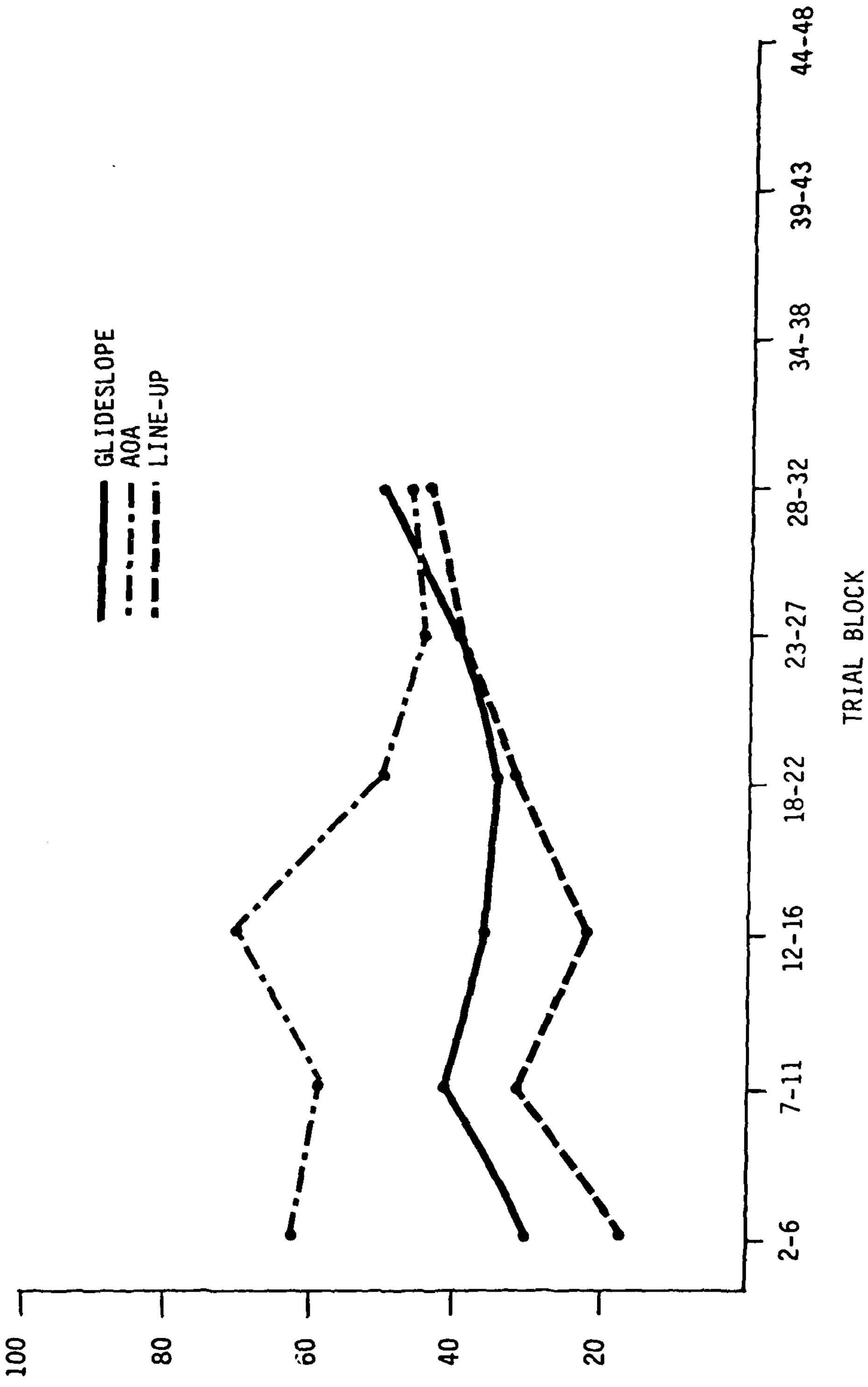

FIGURE B-5. PERCENT OF TIME IN TOLERANCE BY TRIAL BLOCK DURING LAST 6000 FEET OF A DAY, WIDE, STRAIGHT-IN APPROACH TO FIELD.

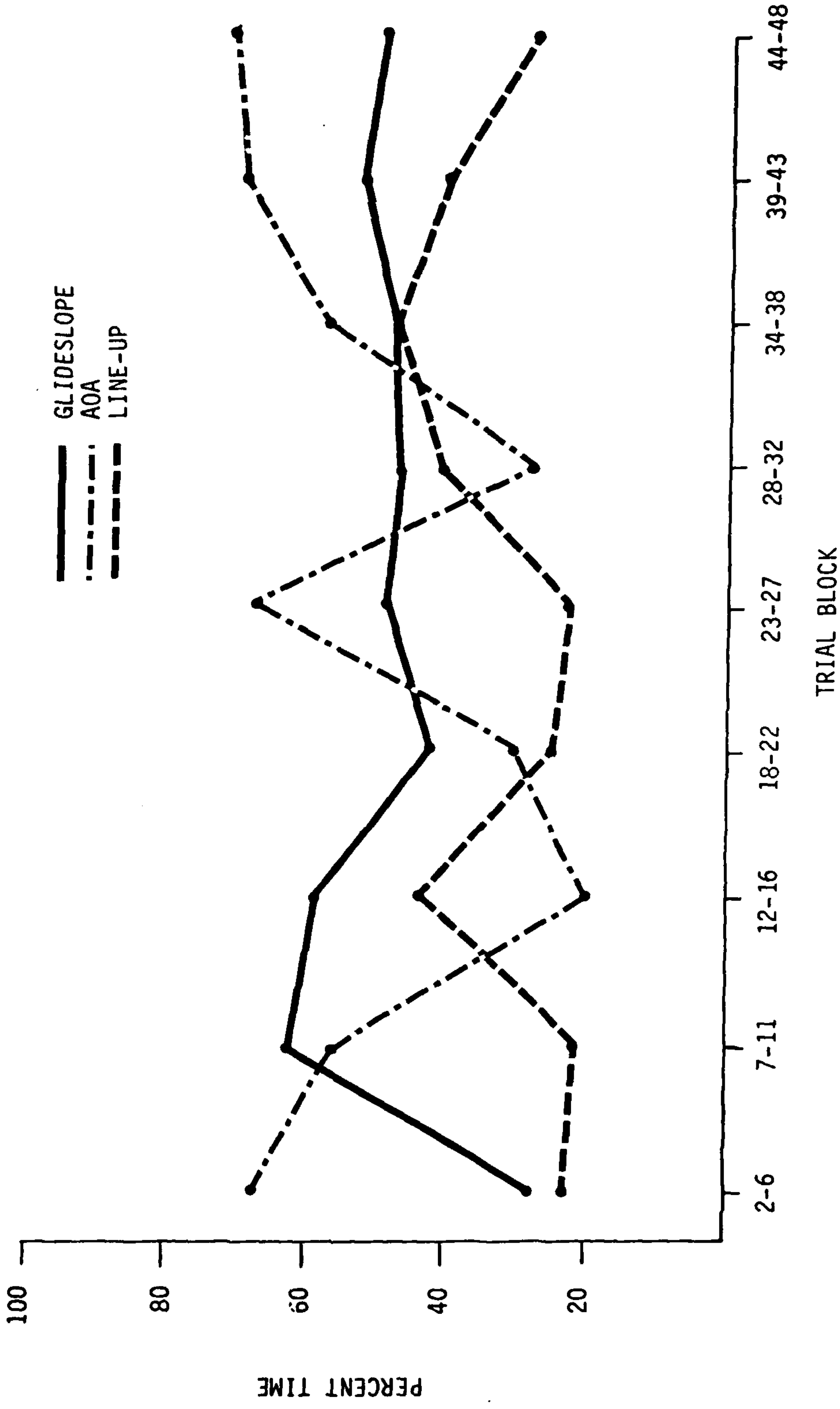

FIGURE B-6. PERCENT OF TIME IN TOLERANCE BY TRIAL BLOCK DURING LAST 6000 FEET OF A NIGHT, NARROW, STRAIGHT-IN APPROACH TO FIELD.

Comprehensive data for GS, AOA, and LU are in Tables B-14 through B-19. Percents in tolerance are given for four segments of the approach. As shown in column headings, these are: (1) from entry into FLOLS space (FLSP) to roll (for circling approaches) or from 6000 to 4500 feet from carrier (for straight-in approaches); (2) from roll to 3000 feet (circling) or 4500 to 2000 feet (straight-in); (3) from 3000 to 1000 feet (both); and (4) from 1000 feet to ramp (both).

AIRCRAFT PERFORMANCE

Combined percents of "OK" and "(OK)" ratings during FCLP and on carrier qualification trials (CQ) are shown in Table B-20 for all seven subjects who participated in the pilot study. Because their regularly scheduled boat trip following FCLP was cancelled, they went through FCLP a second time prior to carrier qualification trials. (Only data for the first FCLP were available, however, and only these FCLP data appear in Table B-20.) As shown in Figure B-7, FCLP performance was similar overall to that for a combined group of 98 subjects from three FCLP locations for whom data were obtained prior to the pilot study (see companion Phase I report). Except for the third hop, however, the pilot study subjects performed less well than the 29 of the 98 earlier subjects who were from the same FCLP location (Meridian, Mississippi) as the pilot subjects.

An additional point of interest is that all pilot study subjects obtained Carrier Qualification on the first series of attempts, and five of the seven in the minimum number of trials (six). The other two subjects required nine trials each, which is similar to the modal value of eight-nine trials found for earlier subjects. It is also apparent in Table B-20, however, that a number of traps received "no grade" because the pilot aimed at a point on the deck instead of tracking the ball.

These comparisons are moot, however. Each pilot study subject had a different set of VTRS conditions, some of which were less than satisfactory for efficient performance. Also, due to the cancellation of their first scheduled boat trip, the pilot study subjects had more than usual FCLP experience. Finally, there is strong evidence (see Appendix C of companion Phase I report) that separate groups of pilots undergoing FCLP differ considerably, and logistic constraints on the selection of subjects for the pilot study did not permit the selection of a suitable control group to compare with them.

TABLE B-14. PERCENTS OF TIME IN TOLERANCE FOR GLIDESLOPE (GS), ANGLE OF ATTACK (AOA), AND LINE-UP (LU) FOR PILOT WHO FLEW A DAY, WIDE, CIRCLING APPROACH TO CARRIER

Trial	FLSP - Roll			Roll - 3000'			3000' - 1000'			1000' - Ramp		
	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU
1	19	43	11	0	0	0	0	0	0	0	7	3
2	26	10	0	0	0	0	0	0	88	27	50	48
3	0	4	4	0	0	0	12	57	100	16	27	18
4	0	0	5	0	0	0	0	0	0	11	29	48
5	0	37	0	0	0	0	0	0	0	7	75	25
6	0	0	14	0	0	0	0	0	0	0	36	50
7	7	65	13	0	0	0	0	0	0	17	31	36
8	13	58	14	0	0	0	0	0	0	81	53	0
9	7	64	8	0	0	0	0	0	0	7	20	8
10	74	93	4	0	0	0	0	0	100	8	25	14
11	17	69	11	0	0	0	19	78	0	46	41	1
12	19	66	15	0	0	0	0	100	0	4	21	2
13	24	63	11	0	0	0	0	0	0	10	20	7
14	91	90	0	0	15	70	0	43	69	37	33	6
15	14	77	0	35	27	64	48	38	61	40	42	9
16	17	14	6	67	100	100	56	29	64	14	33	0
17	0	81	0	29	0	24	19	20	51	0	33	68
18	4	2	0	0	0	0	0	0	48	0	43	19
19	57	61	0	100	100	0	34	95	59	12	15	31
20	28	59	15	0	0	0	0	100	0	12	26	30
21	31	26	0	0	100	0	0	71	13	20	32	35
22	49	24	0	74	85	50	70	92	55	60	37	10
23	6	42	14	92	0	0	32	3	0	6	19	16
24	15	6	10	86	90	100	92	69	100	14	54	100
25	39	38	19	0	0	0	0	83	0	56	54	28
26	25	64	0	46	25	77	25	39	50	17	22	0
27	45	54	0	0	63	62	0	82	79	11	48	35
28	1	37	10	0	39	100	0	61	35	77	87	0
29	69	82	0	100	30	82	100	49	89	9	55	21
30	52	43	10	100	0	100	100	56	70	83	49	11
31	33	86	0	100	87	92	100	90	95	58	50	76
32	62	29	8	11	31	100	53	63	54	2	47	16
33	37	24	0	0	0	0	0	0	0	0	42	15
34	81	35	0	0	0	0	0	94	0	53	83	83
35	0	42	0	0	0	0	0	0	100	28	47	52
36	78	30	19	0	0	0	0	0	0	36	55	66
37	50	4	15	100	100	0	74	55	0	9	35	49
38	92	31	0	0	0	55	12	16	65	39	38	20
39	51	50	12	0	0	0	0	0	0	31	40	2
40	28	75	0	100	89	23	96	82	72	10	42	0
41	8	59	15	0	0	0	0	0	23	19	39	5
42	24	55	0	0	10	93	46	29	98	18	24	10
43	46	68	0	96	0	0	99	33	69	15	27	17
44	93	82	4	0	0	100	0	56	82	25	69	60
45	52	48	0	100	0	69	100	0	50	24	31	12
46	13	59	17	0	0	0	93	52	0	38	43	42
47	34	72	10	0	0	0	0	0	0	99	69	14
48	74	16	14	100	100	100	82	62	64	38	54	0

TABLE B-15. PERCENTS OF TIME IN TOLERANCE FOR GLIDESLOPE (GS), ANGLE OF ATTACK (AOA), AND LINE-UP (LU) FOR PILOT WHO FLEW A NIGHT, NARROW, STRAIGHT-IN APPROACH TO CARRIER

	6000' - 4500'			4500' - 2000'			3000' - 1000'			1000' - Ramp		
Trial	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU
1	0	0	77	10	28	21	5	46	31	0	43	56
2	2	97	27	31	71	34	16	60	0	5	11	0
3	4	5	39	35	45	4	20	52	0	8	42	0
4	0	100	0	11	43	0	0	94	0	21	61	0
5	13	63	0	8	31	0	0	31	0	6	32	50
6	58	27	4	12	26	31	7	2	0	0	0	51
7	98	10	10	29	1	0	50	0	0	4	5	6
8	0	0	79	35	8	0	0	19	0	31	23	0
9	0	62	92	23	18	75	0	44	26	0	1	61
10	0	0	0	26	7	0	16	11	0	9	11	2
11	0	71	0	0	74	75	33	93	100	49	41	32
12	0	65	0	14	79	75	23	55	73	15	51	0
13	0	63	31	42	31	0	39	78	0	27	23	0
14	2	46	37	63	74	0	21	29	0	0	36	0
15	0	99	50	38	29	23	75	20	0	16	12	0
16	30	35	0	12	64	33	0	88	55	1	2	0
17	0	0	76	75	2	100	82	3	100	0	0	100
18	0	4	[illegible]	52	2	78	30	4	36	39	18	0
19	0	100	26	0	71	74	4	35	22	29	66	0
20	0	62	28	54	88	45	35	65	0	0	26	0
21	30	0	6	85	0	100	42	0	76	0	0	0
22	6	0	0	46	0	80	28	21	48	39	0	0
23	28	4	7	20	9	77	38	28	30	16	14	0
24	0	58	0	61	70	46	60	38	100	47	33	6
25	0	44	0	72	19	37	52	49	98	4	36	18
26	0	79	0	44	93	0	59	80	19	10	32	29
27	0	30	17	78	9	78	36	0	28	19	0	0
28	0	2	0	76	41	0	100	60	7	53	17	100
29	4	62	72	100	13	2	99	0	13	45	0	100
30	0	78	30	0	68	79	0	30	31	0	35	0
31	0	98	44	43	34	20	27	50	68	8	27	43
32	19	2	59	33	0	0	48	0	0	4	0	3
33	26	100	22	0	49	0	0	0	0	51	0	0
34	34	0	24	10	0	0	0	0	0	42	0	0
35	0	13	58	65	14	0	77	32	0	12	25	18
36	0	100	0	61	96	90	46	70	67	47	44	0
37	38	8	0	3	80	23	20	83	71	100	0	100
38	24	100	25	27	82	0	33	52	0	57	67	3
39	0	58	0	37	100	26	24	100	77	35	34	13
40	26	4	100	61	82	36	82	61	9	32	36	0
41	20	100	0	15	100	46	0	100	36	33	36	0
42	0	94	86	24	72	16	0	100	0	0	73	0
43	51	13	100	100	100	3	100	100	0	46	70	0
44	34	100	18	85	69	100	49	94	100	78	19	57
45	0	0	46	36	67	0	28	68	0	25	55	0
46	34	100	48	47	99	0	70	82	0	36	62	0
47	65	80	63	72	92	75	52	100	25	63	100	85
48	48	1	0	18	100	53	52	89	94	36	37	0

TABLE B-16. PERCENTS OF TIME IN TOLERANCE FOR GLIDESLOPE (GS), ANGLE OF ATTACK (AOA), AND LINE-UP (LU) FOR PILOT WHO FLEW A NIGHT, NARROW, CIRCLING APPROACH TO CARRIER

	FLSP - Roll			Roll - 3000'			3000' - 1000'			1000' - Ramp		
Trial	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU
1	17	47	4	0	0	0	0	0	0	0	16	0
2	63	64	0	0	0	0	0	0	40	26	0	22
3	0	60	0	0	12	0	29	0	0	6	12	42
4	31	28	0	0	0	0	0	0	0	17	3	55
5	0	34	0	0	0	0	44	0	0	45	0	28
6	0	0	0	51	0	78	32	0	37	1	25	60
7	0	57	0	82	0	81	100	17	85	80	15	0
8	7	54	0	0	30	2	0	53	36	52	46	18
9	0	39	0	52	22	76	50	46	100	44	37	90
10	34	73	0	0	49	0	0	68	32	18	51	67
11	17	67	0	23	12	57	50	23	72	16	13	50
12	6	32	0	0	55	0	9	91	0	45	74	70
13	59	42	0	0	0	0	0	20	2	65	89	92
14	56	23	5	21	0	100	5	0	100	23	35	38
15	41	61	0	50	58	38	23	56	71	15	40	26
16	10	25	0	0	42	67	0	79	100	38	45	25
17	16	62	0	0	18	80	6	51	76	9	19	40
18	18	36	14	23	56	74	15	59	48	16	13	66
19	7	27	27	53	0	100	63	0	100	9	24	25
20	0	31	0	0	0	0	0	0	0	7	20	49
21	91	53	12	0	0	26	9	0	60	13	21	58
22	0	51	0	38	7	0	26	30	21	21	33	60
23	10	32	0	0	0	0	0	20	0	45	24	40
24	74	20	19	34	0	0	25	0	0	8	29	30
25	40	50	0	25	0	0	51	0	27	60	42	95
26	29	60	0	64	0	31	32	4	63	12	24	53
27	0	60	0	0	0	0	0	0	0	25	46	0
28	0	54	0	44	8	0	64	40	17	38	51	50
29	25	86	14	0	63	67	10	36	81	24	40	11
30	0	61	19	48	0	63	43	0	34	16	40	38
31	63	24	10	0	0	0	100	0	0	12	22	12
32	5	41	12	0	33	0	0	56	0	1	20	47

TABLE B-17. PERCENTS OF TIME IN TOLERANCE FOR GLIDESLOPE (GS), ANGLE OF ATTACK (AOA), AND LINE-UP (LU) FOR PILOT WHO FLEW A DAY, WIDE, CIRCLING APPROACH TO FIELD

	FLSP - Roll			Roll - 3000'			3000' - 1000'			1000' - Ramp		
Trial	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU
1	18	9	24	0	0	0	0	0	0	0	0	0
2	2	4	0	0	0	0	0	0	0	0	0	0
3	10	16	53	0	0	0	0	0	0	0	0	0
4	5	38	11	0	0	0	0	0	0	0	0	0
5	31	23	23	0	0	0	0	0	0	0	0	0
6	21	41	36	0	0	0	0	0	0	0	0	0
7	14	35	6	0	0	0	0	0	0	0	0	0
8	4	7	49	0	0	0	0	0	0	0	0	0
9	29	14	61	0	0	0	0	0	0	0	0	0
10	20	25	6	0	0	0	0	0	0	0	0	0
11	15	27	41	0	0	0	0	0	0	0	0	0
12	5	8	36	0	0	0	0	0	0	0	0	0
13	0	53	7	11	0	53	12	21	99	23	29	100
14	32	40	33	0	0	0	0	0	0	0	0	0
15	31	10	45	0	0	0	0	0	0	0	0	0
16	33	29	48	0	0	0	0	0	0	0	0	0
17	30	48	20	80	0	0	64	31	10	58	34	66
18	0	46	28	26	0	42	62	0	3	37	21	61
19	26	1	0	0	70	0	0	37	40	34	13	88
20	35	37	7	15	0	25	20	0	65	17	10	100
21	18	65	0	58	31	32	49	32	68	28	27	87
22	0	6	6	18	0	15	22	0	51	17	17	89
23	7	0	21	19	0	88	28	0	58	42	0	100
24	49	0	0	19	0	0	21	2	37	16	24	59
25	53	0	12	0	0	0	0	0	100	17	24	45
26	33	0	12	0	0	0	23	0	100	72	38	100
27	35	48	8	79	0	100	86	21	100	57	93	100
28	25	18	14	0	0	100	51	33	100	43	49	86
29	15	3	6	0	0	100	12	0	100	46	20	83
30	13	4	5	0	0	0	0	0	0	0	0	96
31	6	11	21	0	0	0	13	0	100	42	0	84
32	46	3	9	100	0	100	100	34	100	25	56	58
34	46	11	0	0	0	0	0	0	0	25	42	75
34	41	32	0	0	0	0	100	100	0	32	52	100
35	17	14	0	0	0	0	0	0	0	0	32	55
36	35	31	0	0	0	0	0	0	0	15	40	44
37	34	28	6	48	0	100	30	4	100	32	56	100
38	32	7	0	0	0	0	19	17	6	46	63	96
39	48	44	0	0	0	33	0	10	65	0	16	91
40	24	86	4	0	0	0	0	60	65	69	32	90
41	42	64	5	0	100	100	0	66	100	17	31	100
42	16	42	1	0	0	0	100	0	100	75	41	100
43	41	49	0	100	0	0	89	12	33	43	74	100
44	19	74	4	0	48	100	0	34	100	17	44	98
45	26	70	14	0	0	0	83	0	100	79	2	69
46	28	76	11	0	4	100	0	33	100	39	99	100
47	44	63	0	35	100	100	20	77	100	18	31	100
48	13	13	0	0	66	82	0	77	88	6	50	83

TABLE B-18. PERCENTS OF TIME IN TOLERANCE FOR GLIDESLOPE (GS), ANGLE OF ATTACK (AOA), AND LINE-UP (LU) FOR PILOT WHO FLEW A DAY, WIDE, STRAIGHT-IN APPROACH TO FIELD

	6000' - 4500'			4500' - 2000'			3000' - 1000'			1000' - Ramp		
Trial	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU
1	10	24	0	16	50	26	0	58	35	19	47	0
2	26	100	0	80	100	39	88	100	58	0	56	0
3	0	100	25	22	52	49	32	56	0	42	53	0
4	2	77	7	31	63	31	64	75	0	38	49	45
5	0	63	0	11	50	0	18	44	9	0	53	41
6	0	95	0	82	30	24	65	30	42	22	39	0
7	100	88	0	34	64	34	23	60	0	23	42	39
8	38	7	46	54	46	0	0	60	0	0	30	43
9	0	28	0	38	83	53	22	81	100	35	33	3
10	37	100	0	100	90	52	100	99	100	52	87	100
11	100	100	0	52	41	25	19	29	43	17	34	0
12	44	80	0	39	46	28	17	30	22	21	50	16
13	0	100	0	0	63	9	14	49	47	32	56	34
14	69	88	0	100	100	0	100	100	0	14	94	57
15	44	100	0	44	89	0	52	71	0	11	73	41
16	26	86	0	54	48	43	40	30	100	15	59	33
17	100	86	80	22	96	54	0	100	87	0	40	0
18	0	74	44	80	81	0	53	59	0	38	41	32
19	0	37	30	0	60	9	34	19	0	18	79	41
20	8	100	0	71	42	87	61	81	77	25	44	100
21	100	61	33	8	26	3	44	0	20	23	49	24
22	100	74	0	25	26	29	2	11	35	0	39	96
23	100	100	35	42	44	74	18	54	24	29	32	6
24	100	11	0	87	47	51	43	3	100	52	48	100
25	0	20	0	0	34	42	0	12	16	0	22	0
26	37	40	0	100	43	74	81	76	57	14	37	100
27	13	100	0	51	75	16	6	30	61	2	77	20
28	0	34	45	73	72	8	49	69	27	32	15	39
29	100	82	0	68	70	67	81	86	89	0	46	15
30	100	0	0	31	38	80	35	7	100	18	53	100
31	56	19	0	48	62	86	78	44	100	47	58	75
32	94	79	0	69	24	97	61	33	100	28	36	87

TABLE B-19. PERCENTS OF TIME IN TOLERANCE FOR GLIDESLOPE (GS), ANGLE OF ATTACK (AOA), AND LINE-UP (LU) FOR PILOT WHO FLEW A NIGHT, NARROW, STRAIGHT-IN APPROACH TO FIELD

	6000' - 4500'			4500' - 2000'			3000' - 1000'			1000' - Ramp		
Trial	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU	GS	AOA	LU
1	20	69	0	36	16	27	0	13	0	18	91	0
2	46	86	0	23	71	12	41	30	53	22	49	16
3	56	78	0	16	86	26	34	82	2	11	64	16
4	67	80	0	24	50	49	25	82	39	13	29	15
5	4	88	0	53	78	2	44	100	37	32	38	31
6	0	92	0	0	29	55	5	60	86	25	66	20
7	18	40	0	83	53	0	55	7	30	42	47	100
8	0	100	0	63	69	0	9	22	11	45	50	25
9	100	72	0	100	53	0	100	1	19	51	36	100
10	100	88	0	67	97	0	72	77	22	58	62	34
11	36	100	0	81	70	33	100	63	58	54	38	0
12	39	39	0	43	53	59	30	49	65	68	30	100
13	100	0	0	34	0	53	15	0	100	0	0	100
14	100	21	0	91	21	13	52	0	53	33	33	0
15	100	45	0	61	0	12	1	0	54	53	0	100
16	100	72	0	88	30	10	56	0	51	61	0	93
17	0	90	0	0	17	95	0	0	100	0	0	100
18	100	23	0	68	3	18	26	0	59	15	44	8
19	100	0	0	92	14	12	53	53	53	11	70	25
20	0	0	0	0	55	0	0	34	9	17	29	64
21	73	55	0	15	62	46	27	0	100	49	3	96
22	100	32	0	38	53	0	38	14	7	22	59	31
23	100	95	0	61	91	0	1	81	3	28	65	51
24	100	39	0	52	43	49	12	10	100	22	55	68
25	100	86	0	86	99	0	43	96	12	27	61	66
26	40	64	0	20	75	0	21	41	0	48	53	42
27	0	80	0	48	76	0	97	46	0	43	60	44
28	100	89	0	100	62	0	94	18	9	15	27	37
29	100	34	8	29	23	100	56	0	100	24	40	100
30	58	81	37	85	34	100	75	3	78	40	18	0
31	0	42	0	0	4	0	0	0	32	28	40	79
32	19	43	0	16	0	0	61	0	32	47	0	100
33	0	0	31	0	0	100	0	0	100	5	1	28
34	6	100	24	38	56	100	29	43	100	43	32	100
35	26	67	0	59	76	25	86	82	76	100	51	15
36	14	83	0	100	48	27	94	74	66	28	60	0
37	40	17	0	58	64	47	81	22	100	15	26	100
38	0	51	0	70	83	27	49	72	79	43	68	100
39	87	100	0	27	67	66	0	46	100	36	31	100
40	27	100	0	100	100	17	96	90	62	31	77	100
41	100	74	0	41	58	38	38	44	97	48	58	24
42	0	76	18	17	35	50	27	86	79	13	40	4
43	100	89	0	100	100	8	100	76	46	93	48	9
44	24	61	0	100	100	43	100	100	100	100	89	72
45	73	96	0	59	92	65	62	100	100	66	71	25
46	62	56	0	62	86	10	60	46	51	47	31	17
47	82	100	0	50	86	11	53	57	51	23	30	8
48	30	52	0	0	67	0	0	80	0	9	13	59

TABLE B-20. COMBINED PERCENTS OF "OK" AND "(OK)" RATINGS FOR PILOT STUDY SUBJECTS DURING FCLP AND CARRIER QUALIFICATION TRIALS

Simulator Condition[a]	FCLP hop								CQ		
	3	4	5	6	7	8	9	10	%OK	%NG[b]	No. of Trials
CNNS	50	0	25	50	0	38	50	50	56	22	9
CDWC	62	12	0	75	62	38	68	75	33	67	6
CNNC	50	33	25	38	38	38	62	75	50	33	6
FDWC	62	12	12	57	38	25	38	75	50	50	6
FDWS	88	67	62	38	86	88	78	38	44	22	9
FNNS	75	62	50	62	71	75	62	75	67	33	6
FNNC[c]	38	25	12	38	75	50	62	56	67	33	6
Mean	61	30	27	51	53	50	56	63	52	37	

[a]The sequence of letters representing simulator conditions represents, in order, the landing scene (Carrier or Field); scene brightness (Day or Night); size of FOV (Wide or Narrow); and type of approach (Circling or Straight-in).

[b]NG stands for "no grade." This rating is assigned to wire traps on which the pilot "dove" for the wire, for example, rather than tracked the ball.

[c]This subject was not able to adapt to this simulator condition soon enough to provide usable data during VTRS practice.

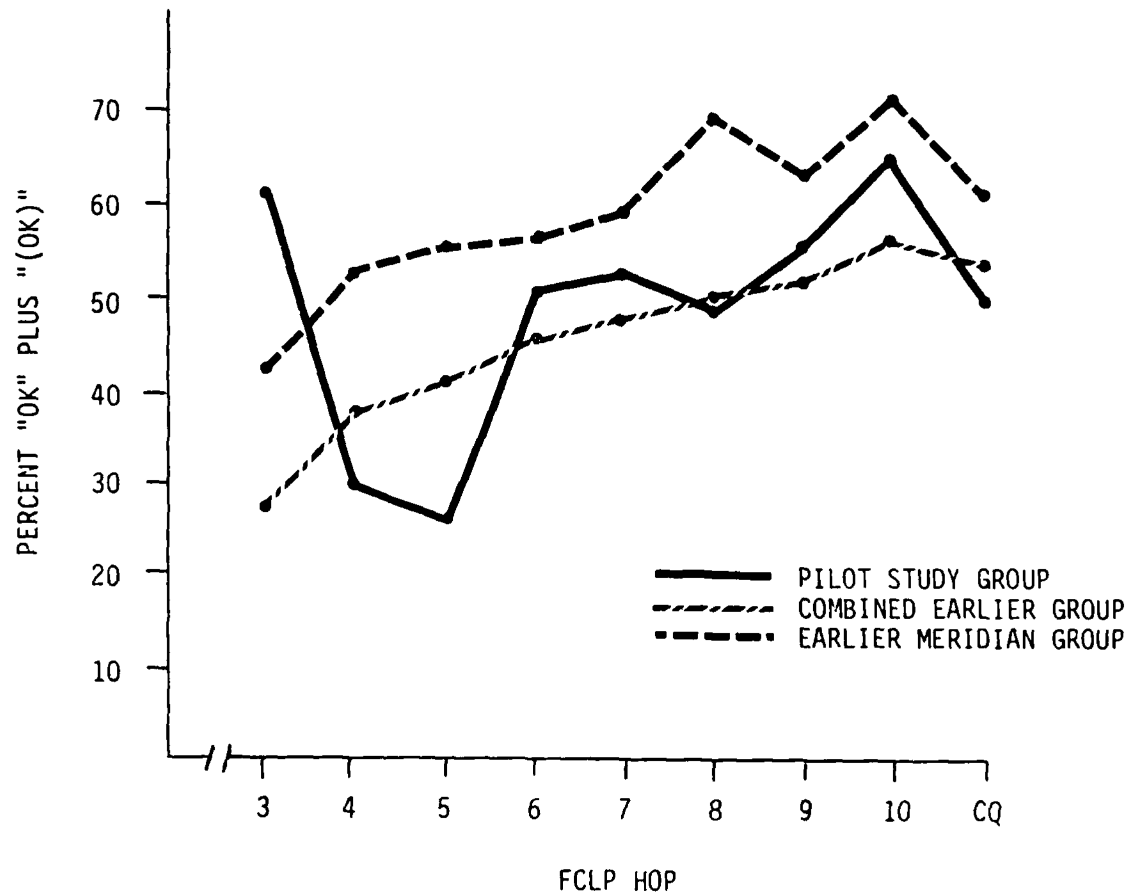

FIGURE B-7. FIELD CARRIER LANDING PRACTICE PERFORMANCE (HOPS 3-10) AND CARRIER QUALIFICATION PERFORMANCE (CQ) FOR SEVEN PILOT STUDY SUBJECTS, 29 EARLIER SUBJECTS FROM MERIDIAN FCLP, AND 98 (82 FOR CQ) EARLIER SUBJECTS COMBINED FROM MERIDIAN, BEEVILLE, AND PENSACOLA FCLPs.

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